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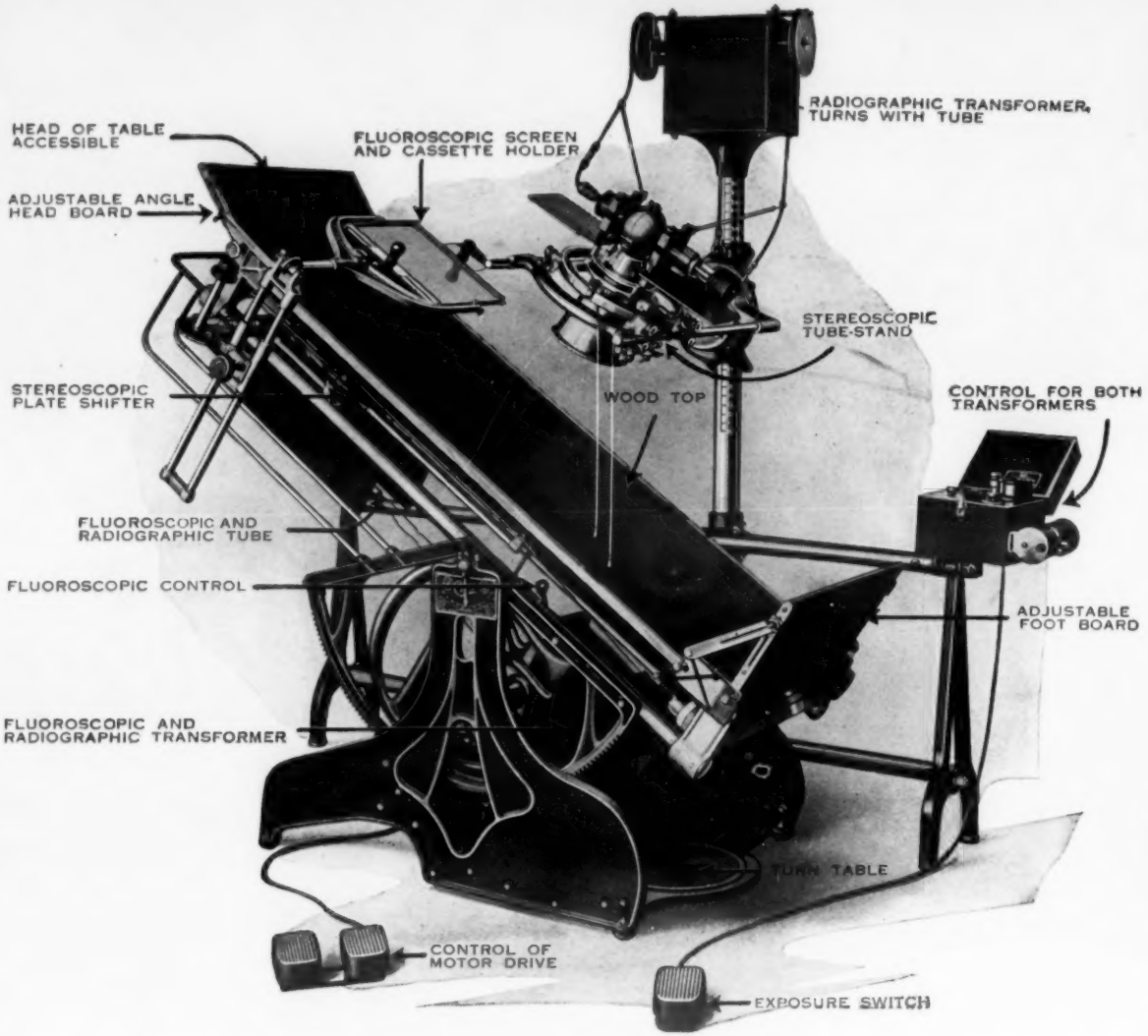


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# X-RAY EVIDENCE OF ABDOMINAL SMALL INTESTINAL STATES EMBODYING AN HYPOTHESIS OF THE TRANSMISSION OF GASTRO-INTESTINAL TENSION*

BY R. WALTER MILLS, M.D.

ST. LOUIS, MISSOURI

THERE seems to have been no considerable effort made to investigate small intestinal normal or abnormal conditions by means of the *x*-ray, this with the exception of lesions of the duodenum which are not included in this presentation. Certain observations as to fundamentals in small intestinal motility have been recorded. The outlines suggesting gross obstruction are recognized. The strikingly apparent dilated and ribbed loops of the obstructed small intestine made visible on the plate by gas and fluid or apparent after barium ingestion have been described (Fig. 11). Several authors have written of the very valuable information derived by the *x*-ray in pathological jejunal and ileal obstructive states of various etiology including congenital bands with resulting kinks (Fig. 12). It is remarkable that so little has been done towards investigating disturbances of the small intestine, the most essential and indispensable part of the alimentary tract. With the exception of gastrojejunal ulcer there does not appear to have been any conception that direct evidence of involvement of the small intestine might be obtained as in the instance of stomach and colon or any effort made to elicit evidence of impairments of its function other than in the instance of ileocecal valve incompetence and ileal stasis. Even the atypical segmentated shadows of the organically involved small intestine have been regarded only as evidence of slight local obstruction.

For the past ten years it has been my custom to write a formal report of each *x*-ray examination, partly for purposes of cross-filing. Any *x*-ray findings not understood were systematically recorded in this report. Among other captions in this cross-file was that of atypical small intestinal loops. I was thus forced to observe and make note of any small intestinal forms that were at all unusual. It gradually became apparent that certain of these forms were associated with certain conditions (Tables I and II); for instance that in colonic obstruction a certain form of small intestine suggesting overdistension was generally present. This naturally led to the idea of recoil or relative stasis which conception once entertained was found to be supported by collateral evidence on every hand; the same for organic conditions. These atypical small intestinal outlines were first noticed and recorded in 1916. In the subsequent five years they have been observed approximately 600 times in the *x*-ray examination of 6,000 persons, naturally with growing frequency as they became better appreciated. For

* Read by invitation at the Twenty-Second Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, (Washington, D. C., September 27–30, 1921.

Material from the private Laboratory of Dr. H. W. Soper and myself and the *X*-Ray laboratory of Washington University Medical Department. My thanks are due to the many colleagues who have favored me with material.

instance in the past six months 205 times in the examination of 750 patients (Table III).

A factor that was fortuitous was that in efforts to determine the exact time of complete gastric emptying for a special study of gastric motility a large series of cases were plated with the patient standing which naturally gave a filled small intestine without considerable pressure artefacts such as result when the plate is taken with the patient prone as is generally done; such plates being consequently non-informative as to the evidence to be mentioned. It is this accidental factor more than all others that accounts for my own findings which have not been apparent because not available to others whose plates were taken with the patient prone.

The subject is difficult to present in abstract form as to functional disturbances because complicated and resting on certain unrecognized principles, perhaps more safely hypotheses, evidence supporting which it may be frankly admitted is as yet to a degree inferential and will only be possible of proof or disproof by prolonged observation. It is thus realized that suggestions to be offered are not proved and so radical that I have hesitancy in presenting them without further investigation. They seem however so appealing and supported by so much evidence that they are submitted to you for consideration and it is hoped will result in your investigation of them.

Since the plate itself is the most effective means of demonstration a statement in proposition form will be given of matter to be presented so far as possible each point illustrated by a print or two with accompanying descriptive legend. It has been disconcerting that my efforts to demonstrate these atypical small intestinal forms to others have not been particularly successful. Roentgenologists of widest experiperience in gastro-intestinal work were unable to appreciate or differentiate outlines that to me seemed perfectly apparent and that I have every reason to believe we are utilizing daily with diagnostic helpfulness. I must conclude that appreciation of such evidence is a matter of experience and education; that one must become as it were sensitized to changes in outlines that at first are not apparent. Each of us has had a similar experience in our gradual education in the matter of duodenal cap deformity, appreciation of gall-stone shadows, and so on.

We have little knowledge of factors governing small intestinal motility. A few seemingly well-founded observations and ideas are current in the literature: That the stomach is the chief regulator of the rate of small intestinal motility; that the rate of motility in the jejunum is very rapid, periodic and segmental, and that ileal motility largely lacks these characteristics; that the rate of motility progressively decreases from the duodenum to the ileocecal valve. Certain conceptions of a small intestinal segmenting peristalsis founded chiefly on observations on animals have been presented. Such action seems not so evident at least difficult of observation in man. The function of the ileocecal mechanism has been differently understood. One teaching is that it essentially prevents a too rapid flow of small intestinal contents into the cecum. The other is that it prevents the reflux of cecal contents into the ileum. My own idea is that it more particularly functions in the latter manner, though as has been taught it doubtless has a dual function, the valvular mechanism preventing reflux and the muscular action in the terminal ileum moderating proximal flow.

The small intestine bears the same relation to habitus as does the stomach and colon as to form, position, tonus, and motility. In sthenic types the arrangement of the whole is higher, the coils are more discrete, of different arrangement, a demonstrably greater degree of tonus and a more rapid rate of motility than in asthenic and hyposthenic subjects. There are suggestions that intra small intestinal tension is greater in sthenic types. Under normal conditions the appearance of the small intestine on the plate is characteristic judged on the basis of physical type (Figs. 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10).

*X*-ray evidence of organic small intestinal lesions may be summarized in a word. Any organic process involving the small intestinal wall either primarily or secondarily will modify the *x*-ray shadow of the contents of the part involved and thus

FIG. 1. Normal small intestine of subject of hypersthenic habitus. Compare with following photo. Small intestine generally high in position showing no tendency to massing in the lower abdomen, its loops discrete and of a high degree of tonus, its motility rapid.

FIG. 2. Photo of woman of hypersthenic habitus. Compare with type of small intestine shown in preceding figure. Physical characteristics are great body weight, short deep thorax, very obtuse intercostal angle, long abdomen, relatively narrow pelvis, high degree of visceral tonus and rapid alimentary motility.

FIG. 3. Normal small intestine of subject of sthenic habitus. Compare with following photo. Characteristic peculiarities essentially those of the hypersthenic (Fig. 1) but less marked. The small intestine is somewhat lower, the loops less separated, of slightly less degree of tonus and less rapid motility.

FIG. 4. Photo of woman of sthenic habitus. Compare with type of small intestine shown in preceding figure. Peculiarities are those of hypersthenic but less marked in degree. Thorax of moderate length with wide but not obtuse intercostal angle, abdomen moderately long, body weight above the average.

render direct diagnostic evidence of its presence; if not as strikingly as in the instance of stomach and colon or yet as suggestively as to the nature of the lesion, none the less positively as to an organic pathological process being present (Figs. 13, 14, 15, 16, 17 and 18).

The following principles concerned in abnormal functional small intestinal conditions may be offered. The first of these is thoroughly recognized and accepted by all of us, the others are not and must as yet be considered hypothetical.

1. When there is organic alimentary obstruction there will be dilatation and motor delay proximal to it, their degree determined by that of the obstruction and the resulting proximal dilatation or hypertrophy. Duodenal ulcer obstruction and its results on stomach form and motility is the commonest instance. To repeat we are all perfectly familiar with this principle, illustration is hardly necessary. It is unrecognized however and of greatest interest that in other portions of the alimentary tract impaired motility and dilatation resulting from obstruction may often be recognized in lesser degree far proximal to the obstructive point and immediately proximal area of frankly apparent motor delay. To illustrate: obstructive carcinoma of the colon results as we all recognize in an immediately proximal dilatation and colonic motor delay, but it seems also that this dilatation is reflected proximally in diminishing degree throughout the entire colon, is especially noticeable in the appendix and is apparent in the form of the small intestine suggesting distension as a result of recoil or relative stasis and may perhaps be reflected as far as the stomach. In addition there is usually present small intestinal gas which while not to be regarded *per se* as pathological, nevertheless usually is and does not seem to occur under what may be termed admirable conditions (Figs. 19, 20, 21, and 22).

It is indeed a question whether delayed progress in the small intestine may not result in impaired gastric motility. It is conceivable that such might occur as the result of inhibition of those stimuli that result in expulsive activity on the part of the stomach as does occur in much greater degree in acute small intestinal obstruction. My attention was attracted to this possibility some years ago in attempting a study of causes of delayed gastric emptying. In that study certain conditions such as chronic appendicitis and gall-bladder disease were found suggestively associated with slow gastric emptying. Thus 15.4 per cent of a considerable series of cases of chronic appendicitis and 34 per cent of a series of gall-bladder disease showed six hour residues on a standard contrast meal; rather a course test considering variability in the time of complete gastric emptying in different types of individuals. The cause of this was not apparent and the study thrown aside in the hope the reason would later be found. The present effort is partly the result of attempts to reach a solution of the problem. Certainly on clinical grounds the explanation of the functional dyspepsias associated with organic surgical and possibly functional nonsurgical conditions, such as constipation, partly on the basis of slow gastric motility would seem attractive. This might result through inhibition secondary to distal small intestinal motor delay or inhibition of proximal (gastric) motility as in gall-bladder disease. One might even conjecture that biliary motility was influenced in some such fashion, i.e., that slow biliary flow was secondary to small intestinal hypomotility in turn the resultant of colonic stasis. Clinically again there are suggestive things. For instance the insistence of certain persons on the cure of their "biliousness," whose explanation no physician may attempt, by means of purgatives which we are thoroughly assured are not cholagogue but which apparently amply serve the end desired from the patient's standpoint.

2. Evidence strongly suggests that the same far reaching proximal recoil occurs in somewhat less degree in functional stasis of the colon as in marked colonic constipation. The *x*-ray apparently shows that not only is there resulting motor delay throughout the entire colon but also secondarily in lesser degree in the small intestine. Such evidence of small intestinal recoil through the form of the small intestinal

FIG. 5. Normal small intestine of subject of hyposthenic habitus. Compare with following photo. Small intestine in toto is somewhat low in position, its various portions massed to a degree and the tonus moderate only, the rate of motility slower than in either of the preceding types.

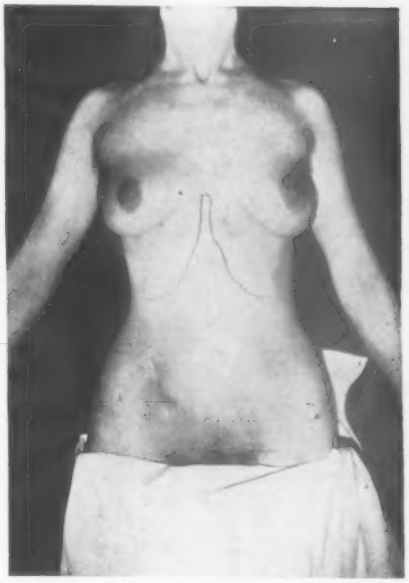

FIG. 6. Photo of woman of hyposthenic habitus. Compare with type of small intestine shown in preceding figure. An average type tending rather to the asthenic than the sthenic. Body weight is rather below the average, thorax moderately long, not deep and with slightly acute intercostal angle. Abdomen somewhat short.

FIG. 7. Normal small intestine of subject of asthenic habitus. Compare with following photo. On the whole position is low, loops show tendency to massing, especially true of ileum. Tonus poor and motility slowest of any type. Differentiation of jejunum and ileum usually more marked in this type.

FIG. 8. Photo of woman of asthenic habitus. Compare with type of small intestine shown in preceding figure. Characterized by general frailty, light body weight, very long gracile shallow thorax with acute intercostal angle. Short abdomen longitudinally, wide pelvis.

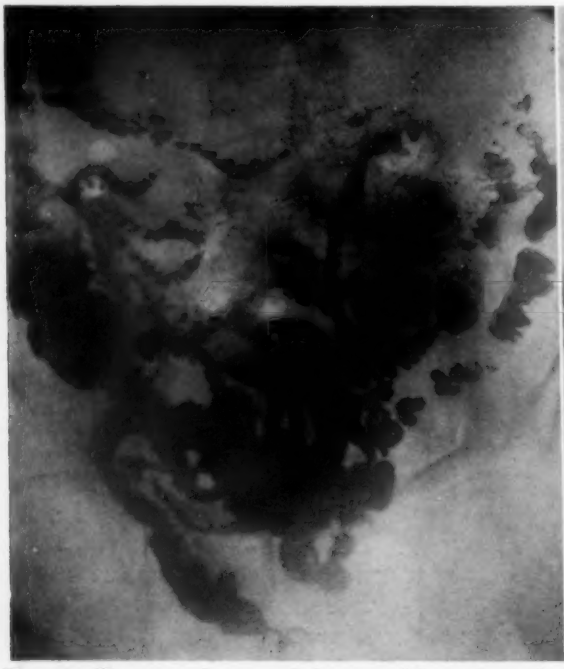

FIG. 9. Extreme degree of hypertonicity of small intestine seen characteristically in subjects of markedly sthenic habitus and a high degree of tonicity, common as to visceral tonicity in general.

FIG. 10. Extreme hypotonicity of small intestine as seen in markedly asthenic and debilitated persons. Gas-filled loops probably result of hypotonicity not necessarily pathological but do not express admirable conditions. Small intestine as here shown not distinguishable from that of pathological causation except through consideration of other factors, especially habitus.

FIG. 11. Characteristic and well-recognized evidence of gross small intestinal obstruction. Dilated herring-bone or ribbed pattern of gas, fluid and barium filled, obstructed and dilated small intestine. Case one of gross obstruction by dense adhesions within sac of post-operative hernia. Operative confirmation.

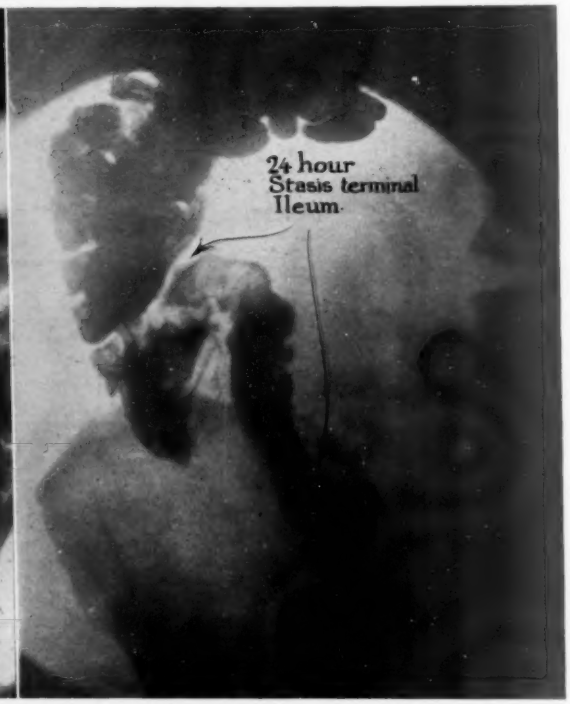


FIG. 12. Stasis in terminal ileum at 24 hours as the result of adhesions secondary to appendicitis with rather extensive peritonitis. Condition probably the expression of crippling of motor mechanism of terminal ileum rather than of obstruction or incompetence of ileocecal apparatus.

FIG. 13. Organic lesion involving small intestine. Here general carcinosis secondary to carcinoma of pancreas. Post-mortem and microscopical confirmation. Characteristic discrete atypical loops of small intestine disorderly arranged showing multiple serrations probably result of locally excited spasms. Outline highly diagnostic of organic lesion but not differentiating as to specific nature.

FIG. 14. Organic lesion involving small intestine. Tubercular peritonitis. Peritoneum 1 cm. thick. Tubercular exudate with universally adherent and matted intestines. Peritoneum studded with tubercles. Operative and microscopical confirmation. Splashy leaf-like pattern indicates organic lesion; elevation of small intestine in toto; suggests ascites.

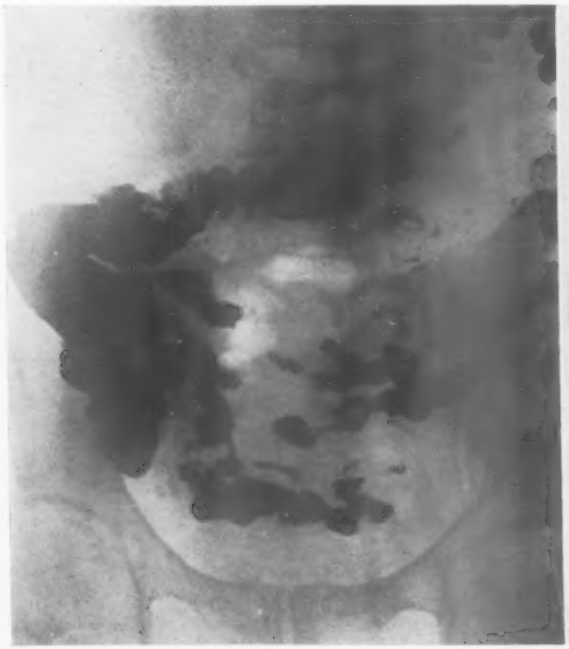

FIG. 15. Organic lesion involving small intestine. Atypical patchy irregular discrete loops of small intestine. Fairly characteristic of and here the result of inflammatory exudate due to rather extensive local peritonitis secondary to acute appendicitis. *X*-ray evidence of highest diagnostic value. Operative confirmation.

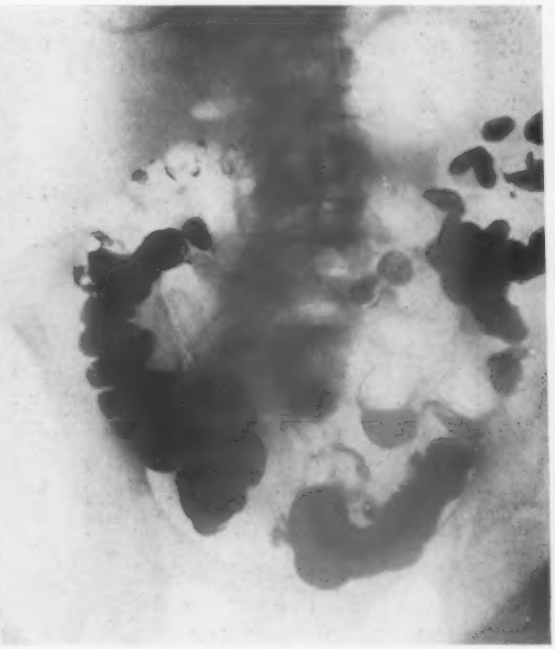

FIG. 16. Slight local small intestinal obstruction due to a few carcinomatous nodules at root of small intestinal mesentery. The local puddling with fluid level is apparent and characteristic of slight obstruction. Operative confirmation.

loops as resulting from constipation naturally does not differ from that indicating the secondary effect attributable to slight or moderate colonic obstructive states. It has been taught that there is no constipation of the small intestine; there is not on the same time ratio, but recall the comparatively rapid motility of the small intestine. Interestingly the fact that it is thus less evident suggests too a greater peristaltic energy on the part of the small intestine with consequent greater tension within it. The ileum can drive its contents into an over-filled even obstructed cecum without great delay; a suggestive idea of many leads and bearings, especially as to whether colonic contents regurgitate or reflux into the terminal ileum under natural conditions as in the case of the barium enema[1] (Figs. 23 and 24).

3. Any alimentary sphincter that is subjected to increased intravisceral tension originating either immediately proximal or distal to it tends to give way and if this tension is sufficiently great the sphincter becomes divulsed and incompetent, dilates in common with the contiguous dilated gut with resulting disturbance of proximal and distal motility. An illustration of the first condition is afforded in the gapping incompetent pylorus occurring in certain cancers of the stomach, the expression of its divulsion resulting from increased intragastric tension in turn the product of decreased intragastric capacity, lessened elasticity of the stomach walls and stomach elevation *in toto*, favoring over-rapid emptying through gravity. This latter statement made advisedly (Fig. 25). Obstruction of the distal duodenum resulting in dilatation of the duodenum proximal to it and of the pylorus and of the stomach in common, is an illustration of the second (Fig. 26). In the first instance that of the gapping incompetent pylorus resulting from contracting cancer of the stomach, distal motility is abnormal—over-rapid largely because the controlling sphincteric action of the pylorus is lost as a result of the factors mentioned. In the second instance that of an obstruction of the distal duodenum with secondary divulsion of the pylorus, proximal motility of not only the duodenum but the stomach as well is interfered with. The pylorus being divulsed duodenum and stomach become one ventricle. Less spectacularly but just as truly, the same dynamics obtain in the instance of every other alimentary sphincter, the cardia, ileocecal mechanism and rectosigmoid (Figs. 27, 28, 29 and 23).

Ileocecal valve incompetence is as has been contended not essentially a thing of the moment effected by barium enema pressure, but instead the reflux of the enema into the terminal ileum expresses its actual acquired and constant relative incompetence, the result of persistent increased intracolonic tension beyond from various causes, most commonly constipation usually contributed to by an inherently low degree of sphincteric tonus as occurring in asthenic states. It is a result and not a cause. The whole subject of ileocecal valve incompetence and ileal stasis as written of by clinicians and roentgenologists is full of suggestions of acquired patulence and secondary small intestinal recoil without the situation apparently being appreciated. Incidentally reflux through the ileocecal valve of the barium enema does not necessarily mean that the same thing occurs under natural conditions, though it usually indicates an acquired patulency. The result is but the expression of the balance between the artificial pressure exerted and the resistance offered. Even under perfectly normal conditions the small intestinal column must feel the resistance of the cecal contents ahead at those times when the sphincter mechanism in the terminal ileum is open. It is only when distal resistance is abnormally great through abnormal conditions and a certain maximum pressure is exceeded that the valve gives way. The whole present conception of abnormal intra-alimentary tension transmission points to one function of the sphincters being that of protectors or guards against pernicious transmission of tensions in addition to the usually appreciated action of favorably retarding motility that the ends of digestion and absorption may be served. The function of the pelvirectal sphincter is to prevent the forming stool

[1] I have since learned that Case has definitely determined this to occur.

FIG. 17. Organic lesion involving small intestine manifested by extreme and atypical hypertonicity, here secondary to general miliary peritoneal tuberculosis. Operative confirmation. *X*-ray evidence suggests irritation due to organic lesion through curious corkscrew or scroll-like atypical spastic loops of small intestine. Evidence diagnostic but not definitely differentiating. (Compare with following figure.)

FIG. 18. Hypertonic small intestine disharmonic on basis of individual's type (asthenic) suggesting result of secondary irritation by organic factor, here general lower abdominal peritoneal irritation (peritonitis ?) secondary to pelvic condition. Note discrete really atypical loops of lower shadows suggesting plastic exudate. *X*-ray evidence suggestive but not conclusive or differentiating.

FIG. 19. Illustrating evidence of transmitted intracolonic hypertension. Marked dilatation of appendix which hangs over pelvic brim, the result of obstructive lesion, carcinoma of ascending colon, possibly secondary to diverticulitis, though cecal diverticula—an unusual location—possibly secondary to hypertension in proximal colon. Post mortem. Condition results in small intestinal stasis. See following figure—same case.

FIG. 20. Small intestinal recoil and stasis from proximal colonic obstruction (carcinoma) shown in dilated atypical loops of small intestine not to be differentiated from result of moderate organic obstruction of distal small intestine, though such not here present. Post mortem. See preceding figure—same case.

FIG. 21. Illustrating evidence of transmission of intestinal hypertension proximal to organic obstructive lesion, here carcinoma of ileac colon. Proximal colonic hypertension suggested in degree of dilatation in descending and distal transverse colon and in form of appendix suggesting slight dilatation probably limited by degree of proximal appendicular sclerosis. Operative confirmation. See following figure—same case.

FIG. 22. Evidence of small intestinal recoil due to obstructive lesion (carcinoma distal colon). *X*-ray evidence through marked local puddling and overfilling with over-fluid contents of small intestinal loops. Same case as preceding figure. Operative confirmation.

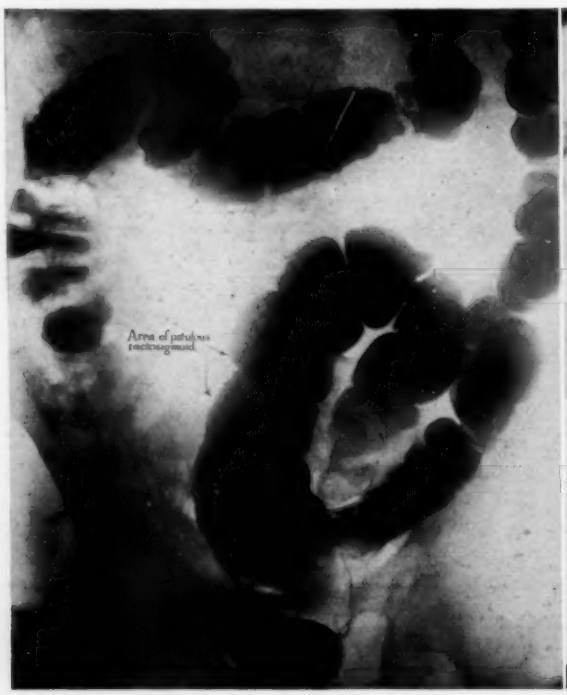


FIG. 23. Colon of extreme constipation with patulence of rectosigmoid sphincter as described by Soper, the result of fecal divulsion. Compare with succeeding figure showing atypical small intestine of same case. Direct course of rectum and pelvic colon and absence of functioning rectosigmoid characteristic.

FIG. 24. Atypical small intestinal loops. Contention that here expressive of small intestinal recoil due to extreme constipation through degree of acquired patulence of ileocecal valve. Patient suffers from profound auto-intoxication. Calomel user. Same case as preceding figure.

FIG. 25. Marked divulsion and insufficiency of cardia and pylorus, "gapping pylorus," characteristic of and here result of general contracting carcinoma of stomach lessening gastric capacity and causing gastric hypomotility through such, together with resulting elevation. Operative confirmation. Post mortem.

FIG. 26. Organic obstructive lesion involving duodenum at juncture of second and third portions and resulting in dilatation of duodenum proximal and of the stomach in common with permanent and marked divulsion—practically obliteration—of the pyloric sphincter. No operative confirmation nor post mortem. Palpable mass later developed corresponding to site of defect. Possibly carcinoma. Possibly lues. (Wassermann four plus.) Patient died shortly afterwards.

FIG. 27. Remarkable permanent divulsion and incompetence of cardia due to decreased abdominal capacity in aged cripple with most marked kyphosis. As the result of the obliteration of the abdominal cavity in large measure through mal statics intragastric tension has been increased through external pressure until the cardia has been forced and rendered incompetent with permanent food content remaining in esophagus. No organic lesion present.

FIG. 28. Permanent divulsion of ileocecal mechanism as the result of exudative colitis. The mechanism of the terminal ileum has been permanently divulsed and rendered incompetent through recoil resulting from distal resistance offered by the rigid colon beyond.

from entering the rectum which is normally empty excepting just before defecation, the urge to which is excited by the descent and presence of feces in it. As has been determined by my associate, Soper,

FIG. 29. "Incompetence of rectosigmoid apparatus" (Soper) divulsed and rendered permanently patulent through colonic stasis with permanent retention of fecal matter in the rectum and pelvic colon doubtless contributed to by the use of purgatives. Also shows location of diverticula at points of maximum intracolonic tension, i.e., in abrupt curves of ileac colon and just proximal to resistance factor—retained rectal fecal column.

through sigmoidoscopic studies, the majority of cases of constipation are concerned either with loss of contractility of the pelvirectal sphincter or its overtonicity (Figs. 29, 23, 30 and 31). In the first case secondary to its divulsion through constant rectal accumulation of feces, in turn caused by ill habits and habituation of the rectum to such fecal presence and by the constant abuse of purgatives exposing the sphincter to frequent unnatural strain. In the second spasticity of the pelvirectal sphincter and contiguous pelvic colon result in proximal fecal retention.

4. Any acquired local lack of resilience in the gut wall as from an inflammatory or other pathological condition will lead to recoil and relative proximal stasis. A sclerosing duodenal ulcer even if it does not actually involve and result in fixed contracture of the pyloric sphincter is frequently associated with a slight or moderate delay in gastric motility—a six hour residue and a degree of gastric dilatation. This may be an expression of final fatigue on the part of the stomach walls from the ulcer resistance offered in the cap, whose function would thus be suggested as that of a shock absorber for gastric peristaltic impulse.[2] In such a duodenal ulcer the pylorus itself is often shown by the plate to be actually open and roentgenoscopically to be incompetent, divulsed by the increased intragastric tension instead of in spasm, usually considered the causative factor in the delayed gastric emptying (Fig. 32). It may even be that the secondary indications, the

FIG. 30. Marked hypertonicity, "spasm of rectosigmoid apparatus" and pelvic colon—according to Soper an essential cause of constipation in colons of essentially a high degree of tonus.

indirect signs of non-obstructive duodenal ulcer, can be accounted for on the basis of

[2] The size and form of the duodenal cap indicates the extent to which it is subjected to pressure—plus its form and direction and the influence of the essential degree of visceral tonus of that person. Where the pylorus is patulous and the cap vertical it will as a rule be large. In heavy hypersthenic persons with high hypertonic stomachs the cap is non-retentive because its downward direction favors non-retention through gravity. It will consequently be small and not apparently greatly differentiated.

abnormal distal resistance. The hyperperistalsis as the direct response; the initial hypermotility as the resultant of hyperperistalsis thus excited plus the incompetence of the pylorus to a degree divulsed through

FIG. 31. Spasm of pelvirectal apparatus, a common cause of constipation in spastic colons (Soper). Exact point of pelvirectal contracture here not shown as it is posterior and technically very difficult of *x*-ray demonstration.

increase in intragastric tension. A stomach not regularly distended tends to contract as in starvation or when the patient is on a soft diet. The gastric hypertonus may thus represent lack of gastric distension, the product of hyperperistalsis and initial hypermotility. A cecum whose elasticity has become impaired as a secondary result of an old appendicular inflammatory process or which offers increased resistance through malposition or even a retrocecal appendix will practically always be associated with an atypical form of small intestine indicating relative stasis as the result of recoil from the increased cecal resistance beyond (Figs. 33 and 34). Clinical medicine furnishes a number of illustrations of the untoward results of abnormal modifications of intravisceral tension of great practical importance: The dilatation of the bile-ducts on the removal of the gall-bladder, the biliary tension equalizer; the occurrence of hydronephrosis in conditions in which the elasticity of the urinary bladder is impaired. According to Matas, in arteriovenous aneurysm not only the vein is dilated but the artery also as far back as the heart as a result of the abnormal resistance encountered by the arterial current at the point of anastomosis. Circulatory results of valvular heart disease furnish many illustrations.

5. Rarely but to be mentioned as a possible principle, lesions lessening the recoil absorbing power of at least certain proximal portions of the alimentary tract determine a greater motility distal to it. A non-ulcerative localized tumor of the body of the stomach with intact expulsive antral mechanism will result in divulsion of the pylorus and resulting dilatation of the proximal duodenum and in small intestinal hypermotility, because the power

FIG. 32. Permanent divulsion and incompetence of pylorus, the result of distal resistance due to sclerosed duodenal ulcer definitely beyond pylorus. Condition possibly suggests cause of duodenal ulcer secondary indications, hypermotility, hyperperistalsis, and hypertonus through resistance offered and physiological response to it.

to absorb peristaltic shock on the part of the stomach has been impaired through loss of elasticity (Fig. 35). The lax pylorus characteristic of gastric ulcer of the pars media is perhaps the result of slight divulsion through similar conditions (Fig. 36).

6. It has been assumed that tension within the alimentary tube if not a constant throughout still may be proximally influenced by changes in distal tension. Conditions favoring transmission of pressure are fairly obvious in the small intestine especially in the ileum; very much less so in the colon, particularly in parts filled with heavy fecal matter. There seems however a factor that makes this quite possible. This factor is the existence of an undescribed slowly progressing peripheral colonic motility about the central fecal column in cylindrical fashion which seems to me to be the essential motility of the colon, certainly of the transverse colon. *X*-ray plates commonly indicate this peripheral motility which is perhaps largely the resultant of intermittent cecal pressure and allows of direct and immediate contact of oncoming matter with the colonic wall for purposes of absorption, an action much furthered by the haustration of the colon. The haustra act as resistance units to this peripheral current, as stations for delay and deliberate absorption from their contents and prevent the dislocation and progression of the column *en masse* as occurs in the infrequent great colonic movements suggestively during which haustration is abolished and the parts of the colon concerned become a cylinder. This type of motility results in peripheral stratified accretion to the haustral contents through inspissation to the formation of scybalae. Scybalae are thus largely the product of gradual surface accumulation. This peripheral current probably makes possible an approach to a common intracolonic pressure on account of its comparative fluidity and allows for the proximal transmission of increased distal tension judging by analogy and *x*-ray evidence (Figs. 37, 38, 39 and 40). There is as mentioned previously much to suggest that colonic tension may thus be transmitted in part on this peripheral current not only throughout the colon but through the ileocecal valve, under normal conditions during periods when it is open, and under abnormal conditions of increased intracolonic tension to its gradually acquired partial or even complete incompetence with secondary recoil and relative stasis in the small intestine. The ileocecal valve may so be forced and become permanently incompetent in the same way that the cardia is divulsed and rendered incompetent in contracting carcinoma of the stomach to the persistence of a constant esophageal content (Fig. 41).

This conception of tension transmission may help to throw light on various problems: On the functional dyspepsias associated with constipation through secondary small intestinal relative stasis and hypertension, especially in the spastic constipations with their more marked pressure symptoms and indicate why there is such variability in symptoms in different types of constipation. On appendicitis and the curiously beneficial results of surgery in certain cases of chronic appendicitis which cause small intestinal recoil through resistance offered and the lack of improvement in others in which the small intestinal stasis is due to permanent pericecal changes. It may help to explain the close relationship between constipation and appendicitis through the irritating effects of stasis in the appendix, just as diverticulitis results from stasis and irritation by retained fecal matter in colonic diverticula. We all know what a proportion of persons suffering from spastic constipation are adorned with appendectomy scars. In this connection it is interesting that according to W. J. Mayo approximately one third of the cases of colonic diverticulitis have had appendectomies, suggesting appendicular irritation as the result of the same colonic hypertension that gave rise to the diverticulosis. The form of the appendix usually suggests the presence of increased intracolonic tension through its outline and direction indicating over-distension and dilatation spectacularly in organic colonic obstruction. In periods of constipation the appendix through its form gives these indications of tension and irritation through increased tenderness which are absent after a thorough defecation.[3] Through its form the appendix is thus a sort of barometer of intracolonic tension.

[3] As an aside it may be noted that the appendix is more tender to pressure when intracolonic tension is increased as in periods of constipation suggesting irritation as a result of such tension. An appendix that is suggestively tender at such a time will generally be much less so after a laxative. The same holds true in the case of a spastic ileac or pelvic colon and in other conditions.

FIG. 33. Dislocation of cecum as a factor offering resistance and resulting in small intestinal recoil (compare with following figure). Condition here the result of exudate secondary to appendicitis. Operative confirmation.

FIG. 34. Atypical small intestinal loops indicating small intestinal recoil from distal resistance resulting from a dislocated cecum secondary to appendicitis. Compare with preceding figure. Same case. Operative confirmation.

FIG. 35. Illustrating immediately distal alimentary dilatation and hypermotility the result of a proximal organic lesion preventing absorption of peristaltic shock. Lesion of unknown etiology. Operative confirmation. Carcinoma (?)—microscopical, negative. Young woman. Illness of five years. Death nine months after present plate taken.

FIG. 36. Showing the characteristic lax pylorus of gastric ulcer possibly the result of impairment of the peristaltic shock-absorbing power of the stomach as the result of the resistance offered through locally lessened elasticity of the ulcer area. A large series of cases show that the pylorus is practically always lax in gastric ulcer and not spastic as heretofore taught.

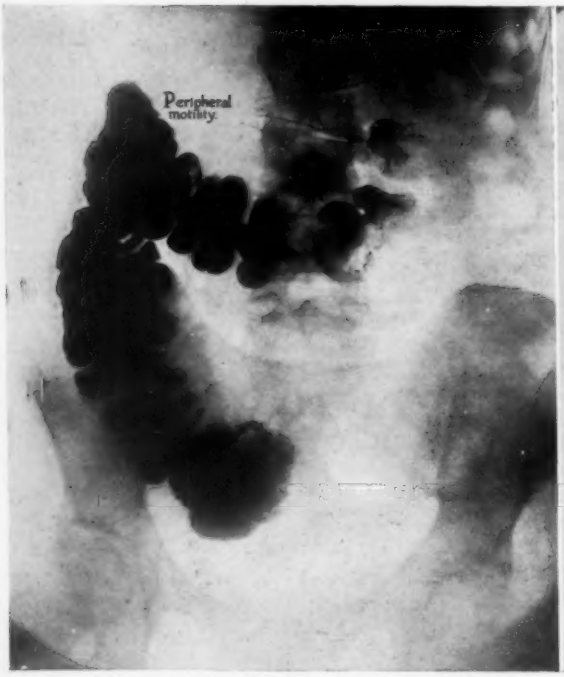


FIG. 37. Illustrating peripheral colonic motility. The peripheral current surrounding unbariumized fecal contents distal to definite "head of column." No other explanation possible. The barium must be progressing by passing between the colonic wall and the contents of the colon.

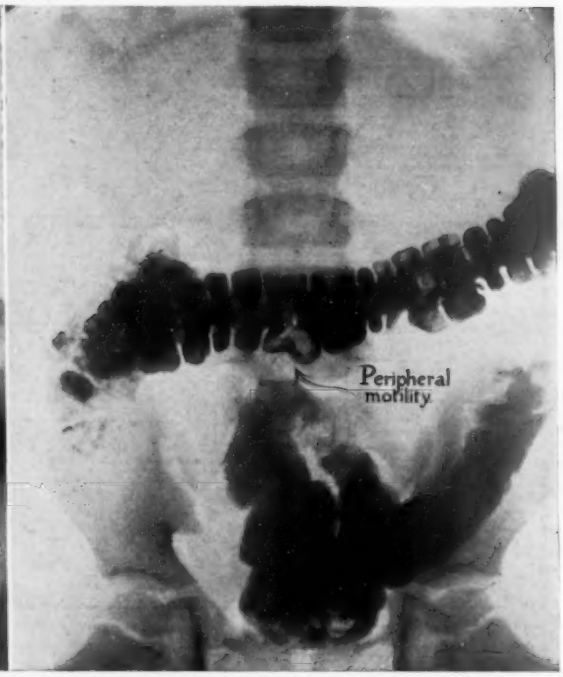


FIG. 38. Illustrating peripheral colonic motility. Showing peripheral colonic current locally about central retained unbariumized fecal matter. Pressure of spine probably the factor here making apparent but does not vitiate—rather emphasizes that peripheral current present.

FIG. 39. Illustrating peripheral colonic motility and stratification of haustral contents. At point indicated by arrow it will be noted that there are multiple strata varying in proportion to their barium content.

FIG. 40. Illustrating peripheral colonic motility. Sketchy outline of median transverse colon, of necessity the result of migratory peripheral current, and of interest because colon proximal free of barium.

FIG. 41. Another case showing actual patulence of the motility retarding sphincteric apparatus of the terminal ileum as the result of distal colon resistance beyond due to marked exudative colitis. The terminal ileum is *not* involved. Operative confirmation.

FIG. 42. Showing dilatation of the appendix as the result of increased colonic tension here the result of involvement of cecum and ascending colon in carcinoma of the ascending colon. Foregoing conditions establish factor of resistance to small intestinal motility. See following figure. Operative confirmation.

FIG. 43. Small intestinal recoil as the result of resistance factor in proximal colon, i.e., carcinoma of ascending colon. See preceding figure, same case. Large amount of small intestinal gas suggestive of pathological condition; probably an expression of acquired atony of the small intestine. Operative confirmation.

FIG. 44. Slight dilatation of appendix the result of marked colonic hypertension here a concomitant of spastic constipation. The appendix of spastic constipation is as a rule large—probably slightly dilated—except in cases where such result is inhibited by a degree of appendicular sclerosis. The appendix is thus a barometer of intracolonic tension.

It sounds fantastical but the appendix may possibly have a tension equalizing function similar to that of the gall-bladder. The well-founded surgical rule against the use of purgatives in cases of acute appendicitis illustrates the practical value of an appreciation of the transmission of colonic tension to the appendix. Those of us who have seen castor oil floating in fecal matter among the intestines at an emergency operation have no doubt of the desirability of any new light on the question. It is generally taught that the rupture of the acutely inflamed appendix after a purgative is the result of excited colonic peristalsis. It is primarily so but the actual force that results in the appendicular blow-out is probably applied through the increase in the common intracolonic and appendicular tension (Figs. 42, 43, 19, 44, 45, and 46).

If true the idea of visceral hypertension, its transmission and results, may resolve certain great problems in gastro-enterology to something of a common relationship. Many cases of constipation, many cases of appendicitis, the formation and points of occurrence of multiple colonic diverticula at points of maximum tension as in the abrupt curves of the pelvic and ileac colons and just proximal to points where the colon is compressed as by uterine fibroid or other obstruction of gradual causation (Figs. 29 and 47). The fact that colonic diverticulosis practically only occurs in sthenic and hypersthenic types, except where an obstruction has developed, in whom visceral tonus is inherently great and alimentary motility more rapid, suggests that intracolonic hypertension is the essential cause of diverticulosis. Purgative abuse is probably a chief immediate contributory causative factor. Colonic redundancy which seems to me for certain reasons to be chiefly acquired and not congenital may be an expression of somewhat similar conditions of increased intracolonic tension resulting from fecal retention reacting in a colon of different type and of an essentially lower degree of tonus. Constipation and purgative abuse seem here also the primary causative factors. If all this be true or only in part true it points to the tremendous importance of the correction of constipation and especially its prophylaxis in children through better home, school and industrial hygiene, popular education and so on.

Visceral hypertension and recoil may help to explain auto-intoxication through small intestinal stasis, recalling our not entirely satisfactory efforts to adequately account for it on the basis of a pathological absorption from the colon. It may help to explain the contention of the functionally dyspeptic patient that he is full—as he interprets it—of gas, which the *x*-ray shows is not gas, his coated tongue, his relief on belching or passing flatus through temporary relief of his intra-alimentary hypertension, his distress after inadequate defecation, his improvement on the improvement of his constipation and his insistence on calomel instead of a diet—the guiding principle—the physic of the ages. It may be that in the future we shall attach as much importance to studies of intra-alimentary tension as we now do to blood-pressure observations. Certainly its actual determination if possible, perhaps by a modified intestinal tube, would be most interesting. It is probable that intra-alimentary tension would be found to be actually very slight could it be determined and expressed by manometry as suggested by the very moderate degree of pressure necessary to cause a barium enema to retrogress. It is disturbance in relative tensions in different locations that is abnormal and disorganizing.

7. Whenever there is over-rapid small intestinal motility from any source, the small intestinal forms will reflect this indicating over-distension and increased fluidity of the intestinal contents more noticeable in the jejunum. The simplest illustration is that of conditions after a gastrojejunostomy in which the small intestine chiefly the jejunum is often obviously over-distended and at operation can be demonstrated to be dilated. The same thing occurs in achylia gastrica in spite of *x*-ray suggestions of a normal gastric motility and normal pyloric sphincteric action. Frequently the same type of distended loops of small intestine are associated with diarrhea suggesting that this is not altogether colonic as has been supposed (Figs. 48 and 49).

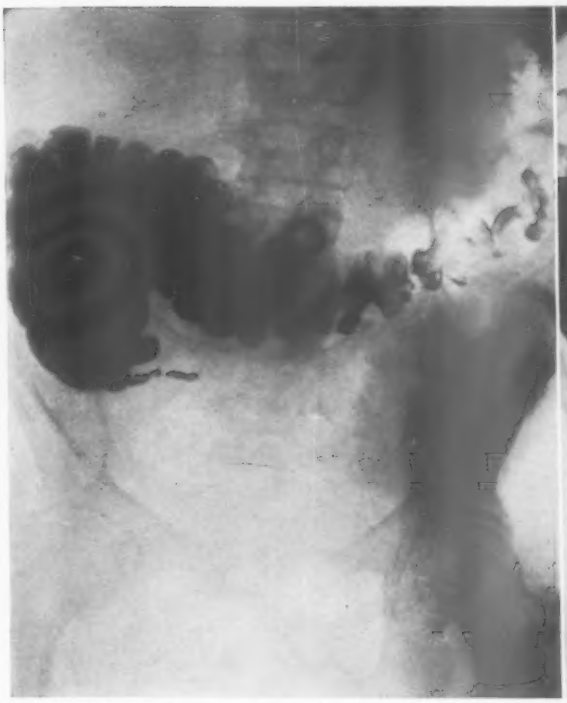

FIG. 45. Appendix showing a degree of hypertension through its form and direction. Case of moderately obstructive carcinoma of pelvic colon. Compare with following figure, same case, after thorough defecation and administration of barium enema. Operative confirmation.

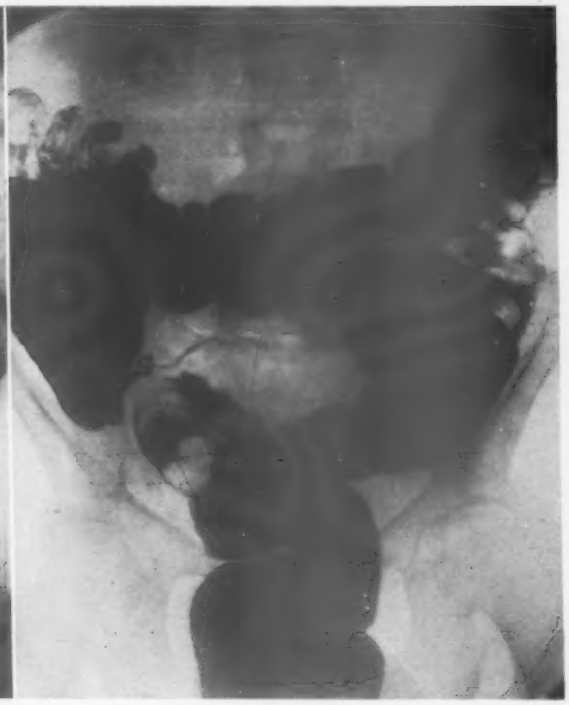

FIG. 46. Form and direction of appendix suggest lack of intracolonic hypertension. Same case shown in preceding figure (obstructive carcinoma of distal colon), but after a thorough laxative and on the administration of a barium enema. Operative confirmation.

FIG. 47. Diverticulosis proximal to extra-alimentary obstruction by great sarcoma originating in bladder and not involving intestines. Patient woman of 79 weighing less than 100 lbs., of hyposthenic habitus. Illustrates probability that diverticula acquired as result of increased intracolonic tension here by extracolonic pressure. Note diverticula just proximal to area of obstruction. Operative confirmation.

FIG. 48. Atypical small intestinal loops characteristic of achylia gastrica and probably an expression of intestinal hypermotility, implying that the diarrhea of achylia gastrica is not entirely colonic and hardly due to gastric hypermotility considered characteristic of achylia but not the case after a barium meal. The form of the loops suggests unusual fluidity of their contents.

FIG. 49. Atypical small intestinal loops the result of simple diarrhea which is suggested by the puddle-like arrangement of small intestinal forms, suggesting that the hypermotility is not limited to the colon.

FIG. 50. Atypical small intestinal loops secondary to distal colonic resistance factor (possibly also general carcinosis) here carcinoma involving descending colon. See following figure. Lesion overlooked three years previous but recently recognized through atypical small intestinal loops in reviewing for this article. No operative confirmation. Patient died shortly afterwards, palpable mass, etc.

FIG. 51. Lesion in descending colon overlooked three years previous and recently discovered through atypical small intestinal loops. See preceding figure.

FIG. 52. Atypical small intestinal loops result of resistance offered by inguinal hernia.

FIG. 53. Pseudo small intestinal recoil such as occurs after the use of laxatives, in conditions of slight diarrhea and the like. Not to be distinguished from forms due to organic conditions except as interpreted through clinical history.

FIG. 54. Plate taken 24 hours after ordinary barium meal showing barium filling distal colon without defecation having occurred. Also indicates peripheral colonic motility by which only it is assumed that such a condition is possible.

FIG. 55. Consider with following figure. Case of beginning scirrhus carcinoma without at this stage incompetence of cardia or evidence of dilatation of duodenum as the result of incompetent pylorus.

FIG. 56. Compare with preceding figure. Same case but two years later as terminal picture of gradually contracting carcinoma of stomach with acquired permanent incompetence of cardia and pylorus to constant esophageal content, resulting dilatation of duodenum and initial gastric hypermotility.

FIG. 57. Atypical small intestinal loops suggesting recoil from distal colonic resistance; factor in this instance colonic diverticulosis.

FIG. 58. Atypical small intestinal loops expressive of slight degree of recoil secondary to colonic resistance; factor in this instance profound colonic stasis due to inhibition from rectal ulcers.

FIG. 59. Atypical small intestinal loops suggestive of recoil due to colonic resistance; factor in this instance constipation and marked spasticity of colon. Small intestinal gas suggestive of degree of acquired small intestinal hypotonicity.

FIG. 60. Atypical small intestinal loops indicating recoil possibly best stasis secondary to highly obstructive carcinoma distal transverse colon. Operative confirmation.

There are arguments against the idea of a relative small intestinal stasis. It may perhaps be justly assumed that the presence of atypical small intestinal forms lacks the conclusiveness of a time motility pressure determining experiment. It is admitted; yet I must urge the overwhelming and suggestive constancy of such findings as have been mentioned in association with certain conditions. It must answer for the present; there are no observations as to the exact rate of small intestinal motility even under normal dietary conditions, a tremendously difficult problem considering physical type and individual variation as to the rate of alimentary motility in response to the same test in different persons. A most refreshing experience has been that in two instances I have been able to predict obstructive organic lesions of the colon overlooked at the time of examination several years previous from the form of the small intestine in reviewing plates for this article (Figs. 50 and 51).

The fact that atypical small intestinal forms are seen after appendectomy without persistence of symptoms is interrogating. Yet the impression is that they are less marked; the reaction may be lesser in degree, or there may be a persistence of acquired hypotonicity without hypertension sufficient to cause symptoms.

The most effective argument against the whole idea is that lesser grades of organic small intestinal obstruction are not associated with exactly the same clinical picture as in functional dyspepsia. However it would be easier to account for this dissimilarity of symptoms as between these conditions on the ground of dissimilar conditions and the probability of a different protective response and individual nervous sensitization than to discount entirely evidence in favor of the conception. There are frequent cases of functional dyspepsia in which the pressure symptoms attributed by the patient to 'gas' are marked yet no commensurate atypical small intestinal forms are apparent on the plate; yet there may be an intra-intestinal hypertension without dilatation through

FIG. 61. Markedly atypical small intestinal loops indicative of recoil if not of stasis, here secondary to carcinoma, involving cecum and probably there primary. Operative confirmation.

FIG. 62. Highly atypical small intestinal loops result of old peritoneal exudate secondary to appendicitis. *X*-ray evidence of highest practical diagnostic value.

the response of increased tonus on the part of the intestinal wall or other protective reactions. Occasionally the same type of small intestinal loops is to be seen in asthenics and debilitated persons, in cases of hernia (though in this latter instance there may be suggestive resulting symptoms) and after laxatives. Still many sorts of valuable information must be judged in the light of their exceptions. The foregoing emphasizes that the interpretation of atypical small intestinal forms is decidedly a matter of judgment after the consideration of various influencing factors (Figs. 10, 52 and 53).

It may be objected that in this day of complicated physiological studies of alimentary secretions, endocrine disturbances, neuromuscular reactions, and so on, that so simple a mechanical theory is inadequate and improbable. It may be so, yet our most effective knowledge of alimentary disturbances has been gained through an understanding of motility and its abnormalities. Often the directly active forces in the causation of disease are comparatively simple.

I can think of no argument that would discredit the idea of a peripheral colonic motility. I can demonstrate it in a thousand plates—any colon plate taken at a suitable time after a fed test. How is it that the head of the barium column seems to slowly and faintly progress across the transverse colon without dislocating the contents ahead. Instead, barium first appears distally as a thin film outlining the already filled colon—not mixing with its contents but surrounding them. Not very infrequently barium will be seen to have reached the rectum by the time the stomach is empty without a defecation having occurred. It must have passed peripherally. The haustra do not give evidence of having considerably changed. A barium enema given with the colon filled with feces retrogresses peripherally. Often constipated persons taking mineral oil complain of passing it alone without a bowel movement having occurred (Fig. 54). There is reason to think that this peripheral migration at times at least occurs intermittently possibly as a result of periodic expulsive activity of cecum or ascending colon. There is too evidence to suggest that it may progress without proximal propulsion; the median transverse colon alone being sometimes first faintly outlined with the cecum the only other portion of the colon filled. The great colonic movement is but a general collection, clearing the stage for a new setting of the same act (Fig. 37).[4]

TABLE I

INCIDENCE OF ATYPICAL SMALL INTESTINAL FORMS IN SERIES OF 5,735 SUBJECTS DUE TO ORGANIC CONDITIONS

A

[*In Organic Conditions Primarily Involving Small Intestine*]

| | |
|---|---|
| General abdominal carcinomatosis and metastatic carcinoma | 18 |
| Tuberculous peritonitis | 5 |
| Peritonitis and adhesions of other than appendix origin | 44 |
| Meckel's diverticulum | 1 |
| Peritoneal irritation (peritonitis ?) | 2 |
| | 70 |

B

[*Where a Secondary Result of Organic Conditions*]

| | |
|---|---|
| Of cecal-appendix origin | 142 |
| Post-operative conditons after appendectomy | 73 |
| Carcinoma of colon | 14 |
| Colitis | 8 |
| Diverticulosis and diverticulitis | 11 |
| Colonic inhibition stasis, post operative | 1 |
| Hirschsprung's disease | 1 |
| Extra-alimentary tumor pressure | 43 |
| Hernia | 16 |
| Redundant small intestine | 1 |
| | 310 |

TABLE II

INCIDENCE OF ATYPICAL SMALL INTESTINAL FORMS IN SERIES OF 5,735 SUBJECTS DUE TO FUNCTIONAL CONDITIONS

| | |
|---|---|
| Constipation | 43 |
| Achylia | 8 |
| Over-fluidity | 14 |
| Over-prompt gastro-enterostomy stoma | 1 |
| Debility (asthenia) | 4 |
| Ascites | 9 |
| Indeterminable | 77 |
| | 156 |

TABLE III

INCIDENCE OF ATYPICAL SMALL INTESTINAL FORMS

A

*As Recorded in Series of Consecutively Examined Subjects During Past Five Years*

| | |
|---|---|
| Number of subjects | 5,735 |
| Number of atypical small intestinal forms | 536 |
| Percentage of atypical small intestinal forms | 9.3% |

[4] Figs. 55 to 62 are not referred to in the text, but further illustrate points mentioned.

B

*As Recorded in Series of Consecutively Examined Subjects During Past Six Months*

| | |
|---|---|
| Number of subjects | 752 |
| Number of atypical small intestinal forms | 205 |
| Percentage of atypical small intestinal forms | 27.2% |

DISCUSSION

DR. SKINNER. I would like to hear a discussion on this because Dr. Mills' work has fascinated me. I think we are all ready to agree upon internal conformation to body habitus. This is not only a matter of body habitus but it may also be a matter of familial continuity. This has been brought to my attention in many cases not only in the gastro-intestinal tract, but also in the osseous system where we have had the opportunity of raying the second generation. I think as some of us grow in roentgenology we shall have this opportunity of raying the second generation and finding out that the familial type is continued in the gastro-intestinal tract and the osseous system as it is in physiognomy.

The second point is that the diseases of the gastro-intestinal tract, with which we are thoroughly familiar—let us say, gastric ulcer, duodenal ulcer, diverticulosis, chronic appendicitis, are all matters of terminal pathology and that it is necessary for us to engage ourselves with studies such as Dr. Mills presents in order to recognize these conditions before they have developed into the terminal stage. We seem to think that if we make a finding of duodenal ulcer or chronic appendicitis or gastric ulcer that we are rendering the patient great service, but we are only rendering them service in recording something that has affected them to such a degree that it is in the terminal stage and not at a time in the career of their disease when they can prevent this desperate pathological sequence.

One other point in regard to redundant sigmoidal loops. Dr. Mills stated that he felt these were acquired conditions, but I wonder if his experience has permitted him to examine a great number of young children. Since we find redundant sigmoids not only in the chronic intestinal stasis of the adult, but also in that of very young children. We have found chronic intestinal stasis in the very early months of life in desperate constipation. We are inclined to look upon it as congenital in origin or that it develops extremely early in life.

DR. LEWALD. Dr. Mills' paper brings up a field that has been sadly neglected. We have observed several cases of tuberculous peritonitis and tuberculous enteritis in which these findings of the fixed loops of small intestine have been so definite that we had no hesitation in making a diagnosis which has been substantiated by operation in each instance.

I would take issue with Dr. Mills in regard to the question of redundancy of the pelvic colon. We have also had the opportunity of examining a large number of newborn and growing children and we would as positively put ourselves on record as Dr. Mills has in his four types of individuals and say that some individuals are born with short pelvic colons, some with medium length, and others with exceedingly long pelvic colons, and that these conditions remain with the individual throughout life. We are convinced of this because we have had the opportunity of watching children over a period of years and upon reexamining them find each one true to his type. There is an old statement that the child is born with a long pelvic colon and that this is gradually overcome. This statement was made by one of the first pediatricians, Dr. A. Jacobi, but does not seem to be borne out by actual study of individual cases.

DR. STEWART. The reason that we have overlooked so many small intestinal conditions is largely due to the fact that we routinely examine cases, commencing with the esophagus and stomach and making the next observation six hours later. If you want to catch these small intestinal conditions, you must make frequent observations between the meal and the six-hour-period.

DR. CASE. Most of us deal in the larger parts with functional disorders rather than actual organic lesions; hence the very masterly paper of Dr. Mills should prove of very wide interest. I shall preserve it carefully for frequent reference.

I beg to differ with the observations of Dr. Mills in one point only; that is, relative to the regurgitation of ingested material from the cecum into the small intestine. I am perfectly aware of the fact that regurgitation of an enema into the small intestine is a relatively unimportant phenomenon occurring during a very unnatural process; it does not represent what is happening in any physiological process of the body. But I have seen in at least two dozen cases indubitable evidence of regurgitation of ingested opaque food from the colon back into the small intestine after having once completely left the small intestine. Observation was made in this manner: patients given a barium meal at 8 o'clock in the morning; at 5.30 in the afternoon (nine and a half hours after administration) observation was made and recorded, frequently with plates, that the small intestine was empty, all opaque material being in the colon. The following morning, immediately

after breakfast, another observation was made in our routine examinations and in at least two dozen cases opaque material was again found in the small intestine filling the ileum for distances varying from 5 to 15 inches. I therefore feel it is true that ingested food may regurgitate from the colon back into the small intestine. In these very cases, study by the barium enema usually shows an astonishing ileocecal insufficiency with very extensive invasion of the small intestine by the enema.

Dr. Holmes. I want to add one practical point to Dr. Mills' paper. Probably he has already observed it. In cases where there is dilatation of the esophagus it sometimes happens that when the patient is put under an anesthetic that the contents of the stomach regurgitate. I recall one instance in which the results were very bad because the contents of the stomach passed down the trachea while the patient was under ether. Those cases would show definite dilation of the esophagus opening into the stomach. Surgeons should be cautioned to have the stomach washed and cleaned before giving an anesthetic.

Dr. Gray. I want to voice my sincere appreciation of Dr. Mills' paper and ask just one question. I was struck with the clearness with which he shows the rectosigmoidal junction, and want to ask him if these cases of which he showed slides were selected with reference to that, or merely accidentally, and whether he has some direction or posture for making these plates. I do not think I have ever seen plates that show the rectosigmoidal region so clearly.

Dr. Crane. I recall that many years ago Dr. Mills had the best exhibit I ever saw at the American Medical Association where he had literally hundreds of cases charted, showing habitus, position, type of intestines and stomach, and an amount of work which was almost overpowering. In view of the careful tabulation of results which Dr. Mills has been carrying out over a long period of years, we should be very careful indeed in taking issue with him. He undoubtedly knows what he is talking about. When it comes to the discussion of small intestines, we are in the unknown land of the roentgenologist. It would seem from a roentgenological standpoint that the small intestine is very seldom diseased. As a matter of fact, the internist will find disturbances of the small intestine very frequently. I can only hope that Dr. Mills will embody his investigations in book form so that they will be accessible to us.

Dr. Van Zwaluwenburg. It requires considerable temerity to discuss a paper of this sort and quality informally, and I should not undertake it unless asked and unless I had been studying in my own way this particular problem for over six years. For the past six years we have been making a careful and systematic note of the motility of the six main divisions of the gastro-intestinal tract, including the two divisions of the small bowel, the upper and the lower. In that study a great many interesting phenomena have been observed.

Unfortunately, the subject is so complicated that we have never been able to formulate our ideas clearly enough to have them published. I feel certain, however, that the internist is right when he says that the small gut is the most important part of the gastro-intestinal tract; that is where we do all of our digestion and absorption, and that is where we have most of our troubles except those which are purely surgical. I believe many of the conditions which we recognize as surgical are purely secondary: complications and sequelae of conditions not primarily surgical at all.

The subject, moreover, cannot be approached from the purely mechanical point of view. It is not merely a matter of obstructions with proximal dilatations and distal hypermotilities. The subject is far more complicated than that. There must be the influences of the other functions of this portion of the bowel, those of absorption, which depends on digestion, which in turn depends on secretion of the digestive juices. Absorption depends on a number of factors. How shall one explain the observation that one regularly finds a delay in the lower small bowel in cases of tabes mesenterica, and in cirrhosis of the liver, except on the theory of an interference in the absorption function of the intestine and of the portal circulation? Certainly there is no intestinal obstruction in these cases. Why the small bowel hypomotility in obstruction of the pancreatic duct?

Let me further mention the fact that the effect of obstruction is not always a proximal delay. There is the other and opposite phase, that of a compensatory hypermotility. One of our most frequent observations in "obstructive adhesions" about the appendix, is one of hypermotility of the proximal small bowel, not a delayed motility, and so long as this hypermotility is maintained the patient has little or no trouble. When he eats too much or unwisely, there is a failure of this acquired and compensatory hyperkinesis, and when the compensation fails the patient has trouble.

I am convinced the symptoms are not always those of obstruction but frequently due to the effort of compensation. Peristalsis may be so vigorous in its successful efforts to compensate

as to be painful of themselves. So firmly convinced am I of this sequence that I have as little hesitation in diagnosing a "chronic appendicitis" on the evidence of a local hyperkinesis or hypermotility as on the contrary findings.

I should like to have you remember that in our laboratory we are attempting to work entirely without clinical data in order to make the observations purely objective and not subjective. We therefore get all sorts of conditions and without warning: hysteriacs with painful bellies, uremics, diabetics, tabetics, pregnancies, literally anything that can be associated with gastric symptoms. We get no information beforehand and it is up to us to pick out the surgical cases and those which are not.

I want to point out again that this problem is very intricate and that the solution is very far away. I think roentgenologists are losing a great opportunity in so largely limiting their observations to conditions proximal to the duodenojejunal juncture and distal to the ileocecal valve. The great field in the future is in the small gut.

Dr. Mills (closing discussion). Please let me thank you for your discussions, especially their charitableness. I fully realize that the subject is new and as Dr. Van Zwaluwenburg has just said, enormously complicated. I was moved by his observation that he had worked six years at it and felt only like holding his peace.

It is a great field and demands attention, and the sooner we all pay attention to it and fight over it the sooner the truth will be sifted out. With regard to the question of colonic redundancy, I only hazard it as my personal guess that redundancy is essentially acquired rather than congenital. The proposition is subject to many modifications. For instance, we must judge as to the physical type. The colon of the asthenic would often seem redundant if occurring in one of sthenic habitus.

Certain people may have redundant colons which to a degree are congenital; others perhaps are acquired. When I see a big person having a colon enormously redundant in an unusual place as around the hepatic or splenic flexure, I wonder very much whether it is congenital.

With regard to Dr. Stewart's observation on plating people only at the six hour period. The six-hour plate, as a rule, will show the small intestine especially in persons of somewhat slow motility. Where alimentary motility is more rapid an observation is best made sooner.

I had 3,500 cases in which I determined the exact time of emptying of the stomach on the same test. One thousand of these were approximately normal. Another series of 2,500 embodied pathological conditions. In these cases conditions such as appendicitis and gallbladder disease showed a constantly slightly slow gastric motility. Why this is I cannot tell but the inference is obvious; that in some way gastric motility is influenced by distal pathological lesions and that what we call reflex symptoms from such conditions are in reality due to delayed motility. The present presentation is the result of an effort to get light on the subject which it does not solve but has led to interesting findings along other lines.

In regard to Dr. Case's contention about ileal regurgitation. I have not followed the matter as carefully as Dr. Case. It may be noted that Dr. Case has but two dozen cases of actually determined ileal regurgitation in his large material. The question comes up as to whether the two dozen cases to which Dr. Case refers, might not be instances of organic involvement of the terminal ileum.[5]

[5] Dr. Case has since informed me that in certain of these cases an operation was done and no structural abnormalities were found about the ileocecal valve.

Dr. Gray's question with regard to the technique in obtaining plates of the rectosigmoid was inadvertently not answered in the discussion. Certain of these plates are the result of good fortune, others were taken on special technique. We have used a method of injecting barium paste by means of a catheter through a sigmoidoscope, later withdrawn over the catheter, without tension distributing it along the lower pelvic colon and rectum. Others were taken by means of heavily coating the interior of the parts with dry bismuth. Certain others were taken after liquifying bariumized fecal contents with mild laxatives. Various poses were attempted but the most satisfactory were the usual prone pose and as for an ordinary bladder plate.

# A CONCEPTION OF CHEST X-RAY DENSITIES BASED ON A STUDY OF GRANITE DUST INHALATION

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BARRE, VERMONT

DURING the prosecution of an investigation of the granite cutting industry the *x*-ray phase of the medical work naturally assumed a position of major importance for one came to rely upon it to a certain extent as indicating just what was taking place in the granite cutter's chest. The one question above all others requiring an answer was represented by the following: Does the roentgenogram show evidence of tuberculosis? In an attempt to answer this question one naturally became very much interested in densities that were thought to give evidence of the existence of tuberculosis. Many text books were consulted and all the available literature scanned so that a reasonable working basis might be established for recognizing densities that were thought to be suggestive of tuberculosis. The statistician connected with the investigation returned the report that an analysis of the death certificates disclosed the fact that 86 per cent of the deaths were due to tuberculosis and from this it was naturally inferred that many cutters actively engaged in the trade were already in the incipient stage. The object of the medical examinations was to disclose if possible the incidence of tuberculosis among cutters at work, and the committee on Mortality from Tuberculosis in the Dusty Trades appointed by the National Tuberculosis Association under whose guidance the work has been carried on, was of the opinion that the roentgenograms would be of valuable assistance in estimating this incidence.

Early in the course of the examinations, films were checked off as showing densities suggestive of tuberculosis, but as the work advanced it became quite evident that if one continued to report films on the basis of the causal factor one would also be obliged to report films as giving evidence of post-influenzal conditions, lobar pneumonia, bronchopneumonia, carcinoma, sarcoma, lung abscess, pleurisy, etc., but as the cutters coming up for examination considered themselves well, were working every day, and appeared to be in excellent health, one became more perplexed as the work progressed. The return of the physical examination blanks was anxiously awaited and a distinct shock was received when no evidence of either constitutional or physical signs existed in the majority of the men, including those who had been designated as showing on their roentgenograms densities suggestive of tuberculosis. It was naturally thought there must be an error, so we worked together; and when it was quite evident that the physical examination blanks were correct it was then realized that the roentgenograms portrayed various types of pathology, and with this knowledge one relinquished the ability to diagnose other conditions simulating it, because, although there was a profusion of densities, there was absence of constitutional symptoms and definite physical signs.

As the work continued one ceased making a diagnosis on the basis of the causal factor and devoted the time in an endeavor to answer the question: Why do the roentgenograms of granite cutters parallel practically every other type of roentgenogram seen? In looking over textbooks and scanning the literature it seemed nearly always possible to reach for a given film which matched the illustration being studied at the time. One wondered why it seemed possible to duplicate almost all the pathological conditions with the chest films of granite cutters who appeared well, said they were so, and proved it by following daily a strenuous occupation. After this observation the only deduction which seemed warranted was that which led to the conclusion that granite dust inhaled charted the highway for all other irritants gaining access to the lungs by aspiration, whether they were mechanical, bacterial

or chemical. It was realized that a pathological process was being observed, which was slight in its beginnings, generalized in its distribution and slow in its development. This very slowness of development it was thought would perhaps enable one to observe, by means of serial roentgenograms the progress of the densities and their behavior during continued dust inhalation, during absence from the same and the affects of a resumption of dust inhalation following periods of idleness. While isolation in the country and narrowness of environment discouraged one from attempting a study of this kind, still round about one were some 2,000 granite cutters and one could not help but feel a conviction that the subject of chest diseases approached from this angle might bring to light evidence which would suggest channels of thought to others. With this hope serial roentgenograms have been continued for the past two years and autopsies secured whenever possible.

## LITERATURE

*Anatomical.* Miller has brought out some of the following points. The normal flow of the lymph in both pleura and lung is towards the hilum. Lymphatics form a rich plexus in the walls of the bronchial tree. They possess occasional valves which open towards the hilum. No lymphatics have been seen in the walls of the air spaces beyond the ductuli alveolares. The plexus of lymphatics about the pulmonary artery communicates freely with that in the walls of the bronchial tree. Valves have only been seen near the hilum and they open towards the hilum. The pulmonary veins are surrounded by a plexus of lymphatics. The bronchial plexus of lymphatics and the venous plexus of lymphatics are connected by lymphatics which follow those branches of the pulmonary vein which have their origin from the bronchial tree. No valves have been found in the lymphatics situated within the lobule of the lung. There is a rich plexus of lymphatics in the interlobular septa and about those branches of the pulmonary vein which are situated in these septa. Such valves as have been found in the lymphatics about the pulmonary vein have been found in the neighborhood of the hilum and they open towards the hilum. In the pleura there is a rich plexus of lymphatics which is provided with numerous valves. In the collecting trunks leading from this plexus all the valves open towards the hilum. The deep lymphatics and the superficial lymphatics are connected by a short vessel which follows that branch of the pulmonary vein which takes origin from the pleura and passes along the interlobular septum. Between the pleura and the point where the first branch of the pulmonary vein coming from the bronchial tree joins that branch of the pulmonary vein situated in the interlobular septum, valves are found in the connecting lymphatics which open towards the pleura. These valves also prevent the flow of the lymph from the pleural lymphatics into the deep lymphatics. The short lymphatic which connects the superficial and the deep lymphatics furnishes a bypath for the lymph in case there is obstruction to its free flow towards the hilum near the entrance of the second branch coming from its bronchial tree into that branch of the pulmonary vein situated in an interlobular septum. No lymphatics unconnected with the lymph-nodes have been seen leaving the lung.

*Pathological.* The South African Report of the Miners Phthisis Prevention Committee states that "it is important to understand the distribution of the lymphatic channels since it is by their means that dust particles which have been conveyed into the lung are distributed through the organ. Intermediate silicosis may be defined as a diffuse fibrosis due to the gradual accumulation of mineral particles in the lymphatic capillaries as a result of chronic obstruction of the lymphatic circulation." Dr. L. U. Gardner of Saranac Laboratory is in charge of the experimental pathology connected with the investigation, and the following abstract is from his paper read before the National Tuberculosis Association at its annual meeting in 1920. "In guinea-pigs after about three weeks' exposure, small amounts of dust may be found enclosed in mononuclear intra-alveolar cells which often show mitotic figures. These cells

are scattered everywhere in the alveoli from the pleura to the hilum. At about two months some of these intra-alveolar cells have begun to mobilize and have formed considerable collections of cells often so closely packed as to simulate giant cells. These cell masses lie in the alveoli along the course of the ductuli alveolares and about and within the small lymphoid collections occurring in the periphery of the lungs. As Miller has shown, such collections occur at the distal ends of the ductuli alveolares and at the division points of the vessels. Dust has already passed through the lung and lodged in small amounts in the tracheobronchial lymphatics. From three to seven months the process continues with a steady increase in the amount of the dust deposit. The invasion of the lymphoid tissue of the lung is more extensive and the larger nodules at the bifurcation of the bronchioles and bronchi become involved. All of the lymphoid tissue of the lung becomes very active and mitotic figures are very common even in the normally small peripheral collections. If the animal be set aside after dust exposure, the lung makes rapid and effective effort to rid itself of the irritant. The clearing process has only been observed up to three months in animals dusted for seven months previously, but at that time practically all the dust is collected within large aggregations of round or oval mononuclear cells which lie in the immediate vicinity of much enlarged lymph-nodules. Heavy deposits occur within such nodules and within the tracheobronchical lymph-nodes.

*Roentgenological.* In reviewing this phase of the literature one finds a variety of terms used in an endeavor to interpret the densities seen. One cannot but be impressed with the fact that many of these terms are culled from one's experience with life and seem to suggest no pathology. The terms beading, stippling dappling, the likening of densities to the golden rod, the dandelion and the sunflower, presuppose on the part of the reader an experience with the material things of this life paralleling the writer's own, with a resulting conception of the term used coinciding with the conception of the writer. One finds the terms parenchymatous infiltration and perivascular and peribronchial appearing frequently in the literature, and, while such pathological changes may exist, one is dissapointed in his search for autopsy reports giving evidence of having checked up the plate reading with autopsied lung and also in his search for reports on serial roentgenograms following peribronchial and perivascular readings over several years' time. Only in the writings of Dunham does one find a major attempt to correlate the densities seen upon the roentgenograms with the autopsy findings. He has called attention to the fact that the tree-like shadows seen upon the normal chest plate were due to blood-vessels, bronchi and connective tissue, each tree-like shadow being a composite of these three factors; but of the three factors two were constant and one was variable. Of these three the connective tissue which represented the variable factor was the most important and upon the amount present depended the density of the shadow. Attention has been called to the fan found on the roentgenogram in adult tuberculosis, its relation to the lymphatic circulation and the chief cause for its formation due to the limitation of exudate and other pathology. Dunham has shown that the tuberculous lesion starts in the lymphoid tissue within the lung and is spread first through the lymphatics. He does not seem to wish to deny that a tuberculous lesion may start in a capillary or another vessel; nor that it may start within some division of the bronchial tree, but he does seem to wish to assert with emphasis that his research has led him to believe that generally the tubercle bacilli primarily do not cause a lesion in the capillaries or in the air passages, although they must enter the lung by one of these avenues, and that the bacillus is generally removed from the ductulus alveolaris, as is carbon, to the lymphoid tissue centers before the germ has caused a pathological lesion in the air passages. He states that obviously a massive or virulent infection within either a vessel or an air tube, so great that the lymphatic system is overpowered, results in a lesion at such a point. Dunham believes that in

the vast majority of cases of pulmonary tuberculosis the bacillus enters the air passages with the dust and soot and is carried into the smaller bronchial subdivisions as far as the ductulus alveolaris and the ultimate lobule, and that from there it is taken by the large phagocytes before the bacillus has caused any infection at its point of lodgment and is carried to the lymphoid tissue, which is abundant in this locality. If neither the phagocyte nor the lymphoid tissue is able to destroy the invader, or if the lymphatics cannot sufficiently drain the part, a tuberculous lesion develops in or near the lymphoid center which at first is only an abnormal increase of the lymphoid cells. If the bacilli grow instead of being destroyed it indicates a greater effort on the part of the economy resulting in the appearance of epitheloid and giant cells. Thus the course of the tubercle bacillus from the bronchus to the parenchyma of the lung coincides with that followed by the dust and particles of carbon, but the coal pigment is received without causing grave pathological changes while the tubercle bacillus lives, grows, multiplies and destroys.

## SOURCES OF EVIDENCE

As medical advisor to the Granite Cutters International Association of America it becomes incumbent upon one to study the problem from a number of angles, because one is called upon from time to time to render opinions relative to working hours, rest periods, dust removing devices, etc., and a mass of evidence statistical and otherwise is necessary in order that opinions rendered be based upon a study of the evidence at hand. The evidence for this study was gathered from an economic study of the men, serial films of cutters and from a study of autopsied lungs.

*Evidence Gained From a Study of the Men Themselves.* Knowing that all men were not safe in the industry and that some broke down earlier than others, it became necessary from an economic standpoint to ascertain if possible the type of individual who would not last long in the industry under present working conditions, and suggest that he take up some other trade, because, while the period of apprenticeship is three years, it takes between eight and nine years to bring a cutter to a final degree of excellence. While these men have been studied during the past twelve years, it is only during the past four years that an effort has been made to discover the type of individual who might be accepted as an apprentice, and the type representing a hazard which if accepted would soon break down in the industry and represent an economic loss both to industry and state. It seemed advisable to examine first the survivors to ascertain if possible the individual characteristics they posessed and their mode of life; therefore, cutters who had inhaled granite dust as long as fifty-nine years were examined and detailed data kept of their condition. The economic phase was so important that attention was paid to small details such as the wearing of a moustache, the length of time it had been worn, its growth as to luxuriance, the amount of hair in each nostril, the condition of the nasal septum, the turbinates, lymphoid nodules upon the posterior pharyngeal wall, the size of the the tonsils, the condition of the teeth and the presence externally of enlarged lymph-nodes. Cutters who had broken down were examined and also several hundred cutters who were working all the time in the endeavor to find the type of individual who would last reasonably long in the industry. As a result of all this work one feels able to detect the type of individual representing a hazard and keep him out of the industry and select the individual who would do well. It was found that the upper respiratory tract held the key to the situation and that an individual was a good risk in proportion to the absence of lymphoid tissue in this region. An apprentice with normal turbinates, a smooth pharyngeal wall, tonsils small in size, no evidence externally of enlarged lymph-nodes, represented a desirable type and one who under ordinary conditions would last long in the industry. On the other hand, if a young man twenty years of age should have hypertrophic rhinitis, enlarged tonsils and lymphoid nodules

on the posterior pharyngeal wall, he should keep away from the industry, as he would be likely to break down fairly early under present working conditions without dust removing devices. In case a cutter breaks down the prognosis is influenced by the amount of lymphoid tissue in his upper respiratory tract. Having discovered the lymphoid and non-lymphoid types of individuals, the roentgenograms were checked up in order to ascertain whether the films might be likewise classified. A continued study of them disclosed the fact that, given the same number of exposure years to granite dust inhalation, the cutter with the minimum amount of lymphoid tissue in the upper respiratory tract showed a minimum number of densities on the roentgenogram, while the cutter giving evidence of considerable lymphoid tissue in the upper respiratory tract showed in proportion many densities upon the film. This was especially noticeable in the case of Italians as compared with other nationalities. In view of this fact, is one justified in feeling that the densities seen upon the chest roentgenograms have mainly as their basis changes in the lymphatic system? If one feels that this is the case, it would seem advisable to study these densities in the same individual by means of serial roentgenograms extending over a period of years, so that it may be determined whether the progression of the densities was an outlining of the lymphatics. In order that one may feel reasonably sure that one was not observing a lesion of bacterial origin, it became necessary to witness the densities disappear when absence from work occurred and reappear when work was resumed.

*Evidence Gained From Serial Roentgenograms.* As one is able, from seeing individuals of all ages, to estimate the span of life and divide that span into childhood, youth and old age, so one is able by serial roentgenograms extending over a period of years to divide the densities appearing on the chest roentgenograms of a granite cutter into stages representing the span of chest densities. It seemed almost imperative at first that one should know the sequence of densities and the complete picture they presented from the beginning to the end. If one has not witnessed the total number of acts of a play he would find it difficult to estimate on stepping into a theatre just what phase of the presentation he was viewing; hence, it was felt that until one had witnessed the complete picture develop by means of serial roentgenograms, one would not be in a position to estimate correctly the densities one was viewing at the time. The very slowness of the development of the densities was of material help in this respect.

## NUMBER OF STAGES

Serial roentgenograms disclosed the fact that it was possible, in order of their sequence, to divide the development of the densities seen upon the chest roentgenograms into six stages, as follows: The first density to attract attention in the case of young men entering the industry was that of the hilum and with it to a certain extent appeared the linear trunks, although when the hilum seemed to reach a certain extent the second stage, that of the linear markings, caught one's eye and seemed to demand study. The third stage seemed to do with the circular densities appearing upon the linear markings often spoken of as studding, beading, stippling, and in like terms. These circular densities seemed to appear on the linear markings and at the branching of these markings. The fourth stage seemed to do with the development of the fan-shaped areas, while the fifth witnessed an appearance of a cloud in the periphery of the film, and the sixth beheld this cloud spreading over the lung field towards the hilum. All of these were not observed in any such clean cut manner as the above description would indicate, but rather one stage would be starting as the previous stage was completing.

*Stage I, That of the Hilum.* Attention has been called in a previous report to the difficulty of describing a normal hilum. It is, however, of prime importance when considering lung densities because if one is willing to look upon it as a lung indicator giving evidence of what has taken place,

considerable information may be gained before other densities are studied. When serial chest roentgenograms become a routine procedure, the importance of the evidence gained from a study of the hilum will be more appreciated. One first observes whether the hilum is prominent as a density. Does it still retain its crescent shape or has the central enlargement occurred causing the crescent to be lost? If it retains its crescent without central enlargement, the respiratory environment of that individual has been nearer the ideal, the dust content of the air being the minimum or near the minimum, the bacterial or chemical invasion of the lung from without has been of small amount. Should the crescent feature be lost because of a central enlargement, and the shadow be markedly increased in extent and density, one knows that one of the following may be concluded: that the respiratory environment has been far from the ideal, the dust content of the air being the maximum or nearer the maximum, the bacterial or chemical invasion of the lung large in amount, or that lung irritating material in small amounts for a long period of time or a large amount for a short period of time has passed over the lymphatics on its way back to the tracheobronchial lymph-nodes. By studying the periphery of the hilum shadow one is able, by noticing its bulgings, to tell the portion of the lung that has labored most in times past, or at present is working ad maximum. Serial roentgenograms disclose the fact that the hilum density decreases in extent and density when absence from granite dust inhalation takes place and again assumes its pathological shape and size when dust inhalation is resumed. As long as the lung field remains free from any evidence of a "thickened pleura" the hilum density maintains its individuality, but the appearance of a shadow in the lung periphery is a signal for an expected change on the part of the hilum until when the "thickened pleura" involves the peripheral and a portion of the midzones of the lung the hilum density is wiped out altogether. Why is it wiped out altogether when "thickened pleura" appears? There must be some connection between the two. Would it not seem from this phenomenon that drainage not being possible by means of the pleural lymphatics back to the tracheobronchial lymph-nodes, the density called hilum shadow is really a lymph stasis disappearing when the supply of lymph from the periphery is cut off, that it has largely a fluid basis and not an anatomical one.

*Glands in the Hilum.* With the hilum density one generally notices in this region circular densities just external to the hilum shadow, which one finds in film readings described as calcified glands or tuberculous glands. When the hilum shadow has reached a certain stage in its extent and density these circular densities appear just external to it. They always seem to follow the development of the hilum. By means of serial roentgenograms these circular densities are seen to appear while dust inhalation is being continued, disappear when absence from work occurs and reappear when granite dust again is inhaled. One wonders if it is possible to produce so quickly, remove and reproduce tuberculous glands. If the cutter continues in the industry these circular densities may increase in area up to between 2 and 3 cm. in diameter when they are then unhesitatingly reported as patches of pleurisy. If they are tuberculous glands, why are they wiped out along with the hilum density when the "thickened pleura" appears in the peripheral zone? One knows that glands occur in this region and that on autopsy are found to be tuberculous, but it would not seem as if there is any direct connection between the circular density seen in the hilum zone and the glands seen at autopsy. Evidence gained from this study warrants one in concluding that these circular densities are valves in the pleural lymphatics, acting as semaphores that endeavor to hold up the irritating material coming in from the lung periphery until the accumulation in the hilum can be moved on. From the academic knowledge that glands exist in this region one wonders if we have jumped to the conclusion that these circular densities in the hilum region were shadows of the glands themselves. Densities in the hilum region are like the shifting sand of the sea, and because a density is present

today it would not seem that one is warranted in assuming that it will be there at the next examination.

*Stage II, That of the Linear Densities.* In studying linear densities it seems possible to divide them into three divisions.

*The First Division.* This consists of the broad densities in the hilum zone most noticeable in what has been called the descending trunks. It is quite possible to demonstrate on roentgenograms the two vessels making up this density; and if one studies the anatomy and carries on serial roentgenograms in dust workers over a period of years, it will be quite evident why the term peribronchial thickening is used. Miller states that lymphatics form a rich plexus in the walls of the bronchial tree, that they possess occasional valves which open towards the hilum. The plexus of lymphatics about the pulmonary artery communicates freely with that in the walls of the bronchial tree. Valves have only been seen near the hilum and they open towards the hilum. The diaphragmatic pleura does not drain back to the hilum but through the ligamentum pulmoni into the preaortic lymph-nodes. Films of granite cutters show that the pleura, covering the lower fourth of the lung, drains through the ligamentum pulmoni; this area does not extend from the periphery to the mediastinum but only for about two-thirds of the diaphragmatic outline, or to where the fissure divides the lung base. This inner portion apparently drains back by means of the lymphatics in the walls of the bronchial tree and those about the pulmonary artery to the hilum, accounting for the broadened shadow in the situation of the descending branches of the bronchial tree. Here again our academic knowledge tells us the descending branches of the bronchial tree and large vessels of the lung are situated, and while tuberculosis may exist in this region one wonders if we are again jumping to conclusions when these widened linear shadows, which come and go in granite cutters, depending on whether granite dust is or is not inhaled, and which seem to be lymph stasis, are supposed to be the direct shadow cast by the lesion found at autopsy.

*The Second Division.* This consists of linear densities appearing mostly in the midzone of the lung field. It will be noticed that these densities have a geometrical arrangement enclosing triangles from which we see Dunham's fans develop. Autopsied lungs and a study of serial roentgenograms seem to show that these densities are septa existing between lobules of the lung which Miller formerly designated as secondary lobules.

*The Third Division.* This consists of finer markings seen in the peripheral zone of the lung and a portion of the midzone. They are the last phase of the linear markings to appear and are the forerunner of "thickened pleura." They resemble a network of threads, but when checked up by means of the roentgenogram with the anatomy of the autopsied lung in cutters of ten years' exposure to dust inhalation, they will be found to coincide with the polyhedral pleural rings. They may be traced from the periphery of the lung field in this arrangement back to the hilum zone and will be found, if traced minutely in their course, to overlie the interlobular septa markings.

*Stage III, That of the Circular Densities.* There seem to be two types of these; one type appearing at the junction of the interlobular septa and on their outlines, while the other appears on the polyhedral rings.

*Stage IV, That of Dunham's Fans.* In another article Dunham's fans have been taken up, but since then the stages of development of an individual fan have been worked out. As circular densities and the formation of fans are bound up in one another, it seems advisable to consider them together; hence Stages III and IV will be considered at the same time. The first development noticed in the formation of an individual fan is the outlining of the fan-shaped area by the interlobular septa. The second development is the appearance of a circular density at the apex of this fan-shaped area, the size of this density depending upon the behavior of the densities peripheral to it when they occur. The third development is the appearance of fine linear markings within this fan-shaped area. The fourth development is the appearance of circular densities

upon the interlobular septa, acting as sides of the fan-shaped area. The fifth is circular densities appearing upon the linear markings within the fan-shaped area. The sixth is a cloudiness appearing over the whole fan-shaped area obscuring its details. An examination of autopsied lungs in a cutter of ten years' exposure and meeting death by accident, shows that on the roentgenogram made at this time these circular areas are on the course of the lymphatics. In the pleura, where the polyhedral rings are injected as if with methylene blue, these circular islands stand out. They appear as would locks in a canal, the dust from behind bulging the valve and filling the canal behind the lock. By reason of the lock ahead being filled with dust, the valve behind it is unable to open. In the development of the fan these circular areas only appeared as the process progressed.

*Stage V, That of the Peripheral Haze.* When the three divisions of linear densities have developed one finds a haze appearing in the periphery of the lung field extending from the clavicle downward to various rib levels. This haze is a forerunner of the "pleural thickening" to come.

*Stage VI, That of the Pleural Lymph Stasis.* The appearance of this thick haze in the lung field has been designated as "thickened pleura," but in cutters having physical signs of a thickened pleura it does not seem possible to demonstrate the presence of this shadow, although we know we must have a thickened pleura. The evidence accumulated would warrant the assertion that we have lymph stasis as a basis of the shadow and that the stasis occurs in the pleura. One is able to witness the formation of this lymph stasis in areas of varying size, it occurring in the granite cutters where autopsies have taught us to expect the greatest amount of dust deposit. It seems to extend from the apex to various rib levels and its variations in extent and intensity are frequent observations in serial roentgenograms of these men.

*Influence Upon Roentgenogram Reading.* In time when other dusty trades are investigated by means of the roentgen ray, these stages will be checked up by other observers. If one comes to the point where he feels he is observing largely manifestations of lymph activity, he then becomes of even greater assistance to the clinician and by relaying to him pathology in its making the clinician is better able to explain his symptoms; at least, that is the way it has worked out in Barre. One wonders if the next step in tuberculosis is not the step which the roentgenologist will take. One who works from the economic side is obliged to admit to himself that an early case from a medical point of view is a far-advanced case from the economic standpoint, for many times it means the end of an industrial life. If one has a feeling that a method is necessary for discovering suitable soil, suitably prepared in the chest of the individual, long before the râle is present as a physical sign, or tuberculous infection has manifested itself, then he will turn to the roentgen ray and a feeling will come, as he works longer in the field of lung densities, that to the roentgenologist must fall the task of searching out the individual whose chest film tells us he is living in a respiratory environment wholly unsuited to him. Twice a year at least a worker in a dusty trade should have a roentgen ray examination of his chest in order that it be determined whether he has reached the suitable soil, suitably prepared stage. With two hundred dusty trades listed in this country one can in a measure realize from an experience with the granite cutting industry the work in store for the roentgenologist. In searching out the individual who represents suitable soil for the development of tuberculosis his services in the future are going to be invaluable, for in no other way, it would seem, are we so well able to portray pathology in its incipient stages. It would seem from this study that we do not have only one infection by the tubercle bacillus and that occurring in childhood, but that we have innumerable infections all through life and that the occurrence of a lesion depends, in part, upon the efficiency of the lymphatics, they acting as the first line of defense in event of an irritant either mechanical, bacterial or chemical, entering the lungs by way of inhalation. The

writer does not wish to close this article without an acknowledgment of the debt he owes Dr. Kennon Dunham for having charted the highway of chest densities. Although up in Northern Vermont, situated many miles from him his stero roentgenography dealing with pulmonary tuberculosis plus his writings have been mainly responsible for progress in this work. As Dr. Dunham found Dr. William Snow Miller's work on anatomy of the lung of valuable assistance, likewise the writer has been driven in his helplessness times without number to Dr. Miller's work. To these two men, Dunham and Miller, he owes a debt which he wishes at this time to acknowledge.

SUMMARY

1. Film densities are like the shifting sand of the sea, and because a density is present at the first examination seems to be no reason for expecting it to be present at a subsequent one.

2. The evidence tends to show that film densities bring into prominence the lung and pleural lymphatics.

3. The same densities are brought into view by various causal factors, apparently being no way in which the roentgenologist can determine, without the aid of the clinical history, the exact cause of the densities he is viewing.

4. When other dusty trades are investigated the necessity for serial roentgenograms in studying a chest condition will be more appreciated.

5. There seems to be a definite manner in which densities progress from stage to stage in the development of chest film densities.

6. It is a question whether the roentgenologist should report on the basis of stages with their pathological import rather than on the basis of the causal factor, which latter it would seem is the clinician's province to determine.

7. The usual basis for diagnosing tuberculous activity is seen so many times on films of granite cutters as they leave and reenter the trade, that it hardly seems possible to consider the phenomena more than an indication of a lung working under stress.

8. It would seem that the next step in tuberculosis is the economic one, when by means of wholesale *x*-ray examinations occupations will be determined which produce a suitable preparation of the soil for the development of a tuberculous process.

# ROENTGEN-RAY TECHNIQUE FOR THE DEMONSTRATION OF SMALL PNEUMOTHORAX*

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IN plates made by the usual technique for examination of the lungs, the perception of small pneumothorax is occasionally easy, more frequently difficult, and most frequently impossible. Unless a pneumothorax is large enough to extend from the anterior to the posterior surface of the plate, there is no area on the plate which is free from lung markings, and these small pneumothoraces do not usually produce the extensive and extreme contrasts of density by which the larger ones are so readily recognized. The definite diagnosis of pneumothorax must depend upon the perception of actual separation of the pleural surfaces. Unless much thickened or covered with exudate, the pleura is not visible in the plate, and the tracing of the surface must depend upon bronchial and pulmonary markings which extend to the surface. If plates are taken with so slight an exposure as to carry the pulmonary markings to the periphery at all points, the central parts of the plates will be so dense as to be unreadable. We have found that this difficulty can be obviated by making stereoscopic plates with different times of exposure. When fused in the stereoscope, the dark plate predominates in the picture, and gives penetration and contrast. The light plate carries the detail to the pleura in the central part, and nearly to the pleura in the lateral part if the lung is normal.

In studying plates taken by this special technique we found that delicate pathological changes are frequently shown which are not visible by the usual technique, and particularly that the combination of detail and penetration which is obtained will in many cases permit an accurate study of the parenchymatous tissue in the region of the hilum. For routine use and general study the separation should be somewhat less than for the study of pneumothorax only. We accordingly give a modified technique for general chest work including small pneumothorax, as well as the technique adopted for the special study of these structures only.

We have experimented with various modifications of current, target distance, and time, with vertical and transverse shift, with various length of tube shift, and with intensifying screens. We find that the granular defects of intensifying screens obscure the finer markings. Without the use of the screen, the technique as given below permits the making of from four to six pairs of plates of a thick chest in any one month without the slightest danger of dermatitis. Owing to shorter exposure this number may be slightly increased in cases of thin chest.

Any standard apparatus and plate changer may be used. The technique as given is for a 7 inch Coolidge tube of medium focus. For a tube of different size or focus, appropriate changes in current, spark gap, and time of exposure must be made. A vertical tube shift must be used, as the transverse shift does not reveal pleural separation at the mediastinum; current 50 ma., 70 kv., 28 inch target plate distance, spark 5 inches at the tube. (We believe that one of the chief causes of variation in the results obtained from the same technique in different laboratories, is the difference of resistance between the switchboard and the tube, due to such causes as corrosion or dust on the trolley, imperfect contacts, etc. In our own laboratory, a spark of 5½ inches at the switchboard corresponds to one of 5 inches at the tube.) Target shift, vertical, 2½ to 3 inches. A greater shift causes an apparent stretching of the pleura so that it is not so visible. Ray filter 3/16 inch aluminum.

The patient is stripped to the waist and placed in the vertical position, either sitting upon a stool or standing facing the plate

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changer, chin resting upon the top and extended sufficiently to bring the apices well below the upper border of the plate. The head should not be rotated to either side, or the tracheal shadow will be distorted. The chest must be perfectly flat against the plate changer as any rotation either way will distort the mediastinal shadows and make difficult the perception of pneumothoraces in this region. The patient is then instructed to place his hands flat upon the great trochanters as suggested by Bray, thumbs pointing forward, arms rotated forward until the upper arm and elbow are pressing firmly against the frame of the plate changer. The tube is then placed in position behind the patient at 28 inches target distance from the plate, with the central ray directed through the 4th dorsal spine, and with the tube shift attachment set for the upper position. The operator at the machine then says to the patient, "Take a deep breath—let it out—take another—hold it and don't move." As soon as the patient's chest is at rest in full expansion, exposure No. 1 is made, the tube and plates are shifted and exposure No. 2 is made on the same inspiration. The entire time of both exposures should not be over six seconds, because even though the patient does not breathe, there are changes in the position of the diaphragm and the thoracic wall after the first few seconds, and these slight movements are sufficient to obscure the finer markings.

To obtain uniform results the time of the exposure must be varied according to the thickness and structure of the chest. The correct use of the classification which we give is a matter of judgment, experience, and careful appraisal of the subject. We often encounter moderate or even advanced tuberculosis in patients who are fleshy, but with very little muscle, as determined by palpation. In such cases less exposure is necessary than in the well muscled. The broad chest with well-developed muscles and very little adipose tissue requires a slightly longer exposure than an ordinary chest of the same thickness at the sternum. The best that a careful description of *x*-ray technique can be expected to do is to furnish a good working basis which must be supplemented by the skill and experience of the technician.

SCHEDULE OF EXPOSURES FOR GENERAL WORK IN UNKNOWN CHESTS

| | Plate 1, seconds | Plate 2, seconds |
|---|---|---|
| Very thin | ¾ | 1¼ |
| Thin chest | 1 | 1½ |
| Medium chest | 1½ | 2 |
| Thick chest | 1¾ | 2½ |
| Very thick, up to | 2¾ | 3½ |

In very thick chests the necessary exposure increases more rapidly.

Somewhat to our surprise we have found that it does not require more exposure to produce a good plate from a chest with considerable fibrosis, than it does from a normal chest, while even a slight amount of active infiltration materially increases the opacity to the rays. If the requests for *x*-ray examination indicate whether the cases are active or inactive, somewhat better plates may be obtained from the following schedule of exposure.

SCHEDULE FOR PLATES MADE AFTER PHYSICAL EXAMINATION

| | *Exposure in Seconds* | | | |
|---|---|---|---|---|
| | *Inactive* | | *Active* | |
| | Plate 1 | Plate 2 | Plate 1 | Plate 2 |
| Very thin | ¾ | 1¼ | ¾ | 1¼ |
| Thin chest | 1 | 1½ | 1¼ | 1¾ |
| Medium chest | 1¼ | 1¾ | 1½ | 2 |
| Thick chest | 1½ | 2 | 1¾ | 2½ |
| Very thick, up to | 2½ | 3¼ | 3 | 3¾ |

If the difference in the time of exposure be greater than the above, the dark plate is likely to predominate unduly in the fused image, and the general diagnostic value is therefore reduced. If the sole purpose of the plate is to demonstrate localized pneumothorax, this partial loss of detail does not matter, and the following schedule will sometimes demonstrate separation of pleural surfaces when the routine diagnostic plates showed indicating signs only.

SCHEDULE FOR SPECIAL PLATES FOR PNEUMOTHORAX ONLY

| | *Exposure in Seconds* | | | | | |
|---|---|---|---|---|---|---|
| | *Inactive* | | *Slightly Active* | | *Active* | |
| | Plate 1 | Plate 2 | Plate 1 | Plate 2 | Plate 1 | Plate 2 |
| Very thin | ¾ | 1¼ | ¾ | 1½ | ¾ | 1½ |
| Thin chest | 1 | 1¾ | 1¼ | 2 | 1½ | 2¼ |
| Medium chest | 1¼ | 2 | 1½ | 2¼ | 1¾ | 2½ |
| Thick chest | 1½ | 2¼ | 1¾ | 2½ | 2 | 2¾ |
| Very thick, up to | 2½ | 3½ | 2¾ | 3¾ | 3 | 4 |

## SPECIAL METHODS OF STUDY

*Plates Made at Full Expiration.* In certain cases of very slight peribronchial involvement, the pulmonary markings may be so slight that pleural surfaces are not outlined even though considerable separation is present, as the density of the lung tissue is not very different from that of the air pocket. In such cases plates made at full expiration will sometimes show the pleural surfaces distinctly, owing to the greater comparative density of the lung tissue.

*Remaking Plates.* Often unforseen densities or unexpectedly clear lungs cause the plates made by any routine to be unsatisfactory. In such cases a second pair may be made with longer or shorter exposures as may be indicated by the first pair.

*Unilateral Lesions.* Of patients with dense involvement on one side and very little on the other, the same pair of plates cannot satisfactorily show both sides of the chest. In such cases the best diagnostic work sometimes requires one pair of plates for each lung with the appropriate exposures.

The interpretation of these plates requires, not necessarily a better knowledge, but a greater familiarity with the normal pulmonary markings than does the interpretation of the plates ordinarily made. Most hospitals and sanatoria deal with cases of tuberculosis which have progressed so far that there are pathological densities which are far deeper than the normal. Such densities are more easily seen in a plate in which the normal markings are completely blotted out. It is easy to read a plate in which any density is abnormal, but a technique which blots out all of the markings of the normal parenchyma must also eliminate the densities which are produced by very early and very slight pathological changes. In our plates normal and pathological densities must be distinguished from each other.

A localized pneumothorax produces certain changes in arrangement, and distortion of the structures in its neighborhood. These produce in the plate certain alterations in position and certain rearrangements of densities which we have called indicating signs. One or more of them are usually present in cases of small pneumothorax, and their presence should lead to a scrutiny of the plates for evidence of separation of pleural surfaces. In the beginning of the study only such small pneumothoraces will be perceived as are clearly outlined throughout their whole extent. In the greater number of these structures the margins are irregular, thin and flat, and the pleural surfaces are too close together for the separation to be perceived throughout its entire extent, therefore when skill is obtained, if definite separation of pleural surface is seen in the central part of the pneumothorax, the outline of the thin boundary is approximately determined from variations of density and from the distortion of the pulmonary markings.

The indicating signs which make us suspect the presence of a localized pneumothorax become permanent if the pneumothorax persists long enough for fibrosis to fix the structures in their new position, but with the disappearance of the pneumo-

thorax they usually become less angular, less clearly outlined, and less conspicuous. Briefly stated, they are as follows:

*A. Areas of Collapsed Lung Tissue.* If there is even slight infiltration partial collapse produces a band or zone of density which does not conform to the usual course of development of the tuberculous process. A partial collapse of more advanced infiltration produces a zone of deep density which is often mistaken for complete consolidation or even for caseous pneumonia.

*B. Areas of Rarefaction.* Very frequently in flat plates the region of a small pneumothorax is as dense as the surrounding parts. Displacement of lung tissue either toward or away from the plate does not alter the density. If there is exudate upon the pleural surfaces, the density in the flat plate may even be greater. In the stereoscopic image a pneumothorax usually appears as a region of lessened density, close scrutiny of which reveals separation of pleural surfaces. If there is sufficient lateral displacement of tissue, even the flat plate shows an area of rarefaction, with an adjoining region of increased density.

*C. Pleural Cusps.* Pointed cusps and tooth-like projections of the pleura are due more frequently to small pneumothoraces than to any other cause.

*D. Deviation of Trachea, Mediastinum, Heart or Diaphragm.* There is usually a localized deviation of some of the movable structures of the thorax in the direction of a localized pneumothorax. A sharply angular deviation of the trachea is an almost certain sign of a localized pneumothorax on the side toward which the deviation points. Deviations of a portion of the mediastinum from long perpendicular bands of adhesions, which are placed under tension by localized pneumothoraces of the tube-like form so common in this region, sometimes cause an apparent increase in the size of the pericardial shadow.

*E. Atypical position or irregular course of normal markings or pathological densities* may be due to displacement or distortion by localized pneumothoraces.

*F. Annular Shadows.* Under certain circumstances small pneumothoraces produce very definite and distinct annular shadows. There are also other pathological conditions which cause them. The majority of small pneumothoraces do not produce well defined annular shadows.

*G. Localized fluid levels* which evidently are not due to cavities.

The method of the study of plates by this technique can be given most briefly by an actual example. In practice, routine reports of such detail would depend upon an adequate personnel with a limited amount of work.

### REPORT OF THE ROENTGENOLOGIST

In Plate 1 the pulmonary markings extend to the pleura, and the vertebral bodies are not visible through the cardiac shadow showing that there is no loss of detail from over-exposure. In Plate 2 the normal pulmonary markings do not quite reach the pleura, the vertebral bodies are faintly visible through the upper part of the mediastinal shadow, and there is sufficient penetration for the separate perception of structures in the region of the hilum. In both plates the outlines of the ribs and diaphragm are clear and distinct. In the stereoscope the image is fused in all parts. Bones symmetrical with no evidence of pathological change. Thorax long and narrow. Ribs slightly depressed and somewhat closer together on the right. Moderate calcification of the upper three costal cartilages on both sides. Diaphragm smooth and regular, angles clear, apparently slightly elevated on right, small pleural cusp near cardiophrenic angle on right. Heart vertical in position, not enlarged. Mediastinal shadow broadened on right and slightly irregular, especially opposite the third dorsal vertebra. Trachea shows angular deviation of right wall at the level of the third dorsal vertebra.

*Right Side.* All densities increased in the hilum region, where there are numerous rounded densities, some of which are large. A somewhat triangular small hazy parenchymatous density extends from the hilum to the interlobar septum about one inch from the main bronchus. A group of dense markings with hazy outline which suggests a small distorted fan extending from the hilum to the mediastinal surface. The vertebral trunks and its branches expand

into a typical but slightly distorted fan at the apex, which appears slightly compressed laterally. The density of the remaining bronchi of the upper lobe is somewhat increased from the hilum about half way to the periphery. The descending bronchi are of somewhat increased, but clearly outlined density.

Both the ascending and descending bronchi which lie nearest the median line seem to be pushed outward, so that there is a curved band, about one-half inch wide, extending from the apex to the diaphragm, in which the bronchi appear to lie more closely together and more parallel than in normal plates. The density of the interbronchial parenchyma is slightly greater in this band than elsewhere. Between this band and the mediastinum is a perpendicular zone of lessened density which contains fewer markings than on the left. This zone broadens out slightly at the diaphragm and its outer angle is formed by the diaphragmatic cusp already mentioned. The pleura is nowhere thickened but shows a sharp pointed projecting cusp opposite the angular deviation of the trachea. The pleura appears pressed against the root of the lung, especially above, so that the root appears partly compressed into a cylindrical form, especially the upper half. Beginning at the upper surface of the root the mediastinal and the visceral pleura are seen to be definitely separated, enclosing an air space which may be traced about half way to the apex, when it merges into an area of rarefaction containing no pulmonary markings. No markings are seen between this space and the observer, but pulmonary markings are plainly made out between this space and the sternum, showing that it does not extend to the anterior wall. The outer boundary of this space is formed by a delicate pleural line which ascends in a somewhat curved direction from the hilum to the apex, and can be traced farther than can the actual separation of pleural surfaces. Below the hilum separation of pleural surfaces may be traced for about 2 inches, enclosing an air pocket like a somewhat flattened tube, which becomes continuous with an area of rarefaction extending to the base. Pulmonary markings may be seen both in front of and behind that part of the air pocket which lies below the hilum. Pleura otherwise normal.

*Left Side.* Moderately numerous rounded densities in the region of the hilum which are clearly outlined. The vertebral trunk and the bronchial branches which supply the first interspace show increased density and an apparently increased number of branches which are clearly outlined and do not extend to the pleura.

All of the bronchial branches radiating from the hilum show increased but well-defined density throughout about one third of their length, markings otherwise apparently normal, pleura normal.

*Interpretation of Roentgen-Ray Findings. Right Side.* Enlargement of bronchial lymph-nodes, some of which are apparently caseous. Peribronchial thickening in the central portion extending to base in lower lobe, small areas of parenchymatous infiltration in the hilum region, focus of infiltration in the apex. The shape and distribution of the lesions and the character of the densities indicates tuberculosis as the most probable cause. Posterior central small pneumothorax apex to hilum, becoming mediastinal from hilum to base. This pneumothorax is permitting slight collapse of the apical lesion. Pathological activity is indicated by hazy character of some of the densities, and clinical activity is indicated by the elevation of the diaphragm and the depression and approximation of the ribs on the right side without other apparent cause. If râles are not present, their absence may be due to the pneumothorax.

*Left Side.* Enlargement of hilum glands, slight peribronchial fibrosis in the region of the hilum and ascending toward the apex. No indication of any active pathological process.

*Diagnosis Indicated by Roentgen-Ray Report.* Pulmonary tuberculosis, incipient, right apex.

*Note.* In advanced disease the involvement at the hilum is continuous with the general process. In disease of long standing there is so much fibrosis in the regions of the hilum and mediastinum that demonstration of small parenchymatous lesions in these regions is difficult. In a

series of plates of early lesions taken by the first technique described above, we found fans, tubercles, or other miniature parenchymatous lesions in 24 per cent, 5 per cent recognizable at a glance, and 19 per cent distorted or overlain by fibrotic markings. By re-examining with a technique especially adapted to the hilum region of each particular case, it is possible to demonstrate active parenchymatous involvement at some point of the mediastinal surface of practically every case of localized mediastinal pneumothorax, often when there is no apical lesion. We wish to acknowledge the assistance rendered us by Mr. Abel Emard, Assistant Roentgenologist.

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## DISCUSSION OF JOHN W. PIERSON'S "DIAGNOSIS OF PULMONARY CONDITIONS IN CHILDREN" *

*Dr. Wittington.* Coming from a tubercular resort, we naturally see and are interested in this condition more than many of you who do not see so much of tuberculosis.

We know that in order to insure healthy generations and lower the vital statistics in tuberculosis, it is necessary to begin in childhood. We know by actual experience in our work that the chest of the child is very susceptible to the roentgen ray. If we make our diagnosis in conjunction with the physiological examinations, we can in a short time restore affected children by proper hygienic and medical treatment, prolong their lives and produce a more healthy generation.

I think you have not taken as much interest in this paper as you should. Investigate your children; examine physical conditions; take morning temperature and afternoon rises; then examine them with the *x*-ray and see what conditions you have. The age of from three to ten is a very important period in a child's life.

*Dr. Pierson (closing discussion).* The appearance which we regard as pathognomonic in tuberculosis is gradual expansion and widening of the mediastinal shadow.

As far as enlargement and calcification of the glands which we see along the larger bronchi are concerned, we do not regard those as pathognomonic processes. We find those things in chronic bronchial pneumonia. Large glands extending out from the mediastinum itself are the ones we think are tubercular. We see great dilatation and increased density of the trunks in tuberculosis and also see the same identical condition in chronic bronchial pneumonia. In both conditions the glands extend out along the main trunks. The only difference is that in tuberculosis we get a very great widening of the mediastinal shadow. That is particularly applicable to young children.

*Dr. Pariseau.* Would you find it easier to have the child rayed on expiration or inspiration?

*Dr. Pierson.* That depends on the age of the child. Some have to be taken fast. We usually take our cases, if we can control them, on inspiration.

*Dr. Parker.* Is there any more tendency to calcification in tuberculosis than in other infection?

*Dr. Pierson.* We have seen as much calcification in so-called chronic bronchial pneumonia as we have in tuberculosis.

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# THE VALUE OF ROENTGEN THERAPY IN DERMATOLOGY*

BY GEORGE M. MACKEE, M.D. AND GEORGE C. ANDREWS, M.D.

NEW YORK CITY

The next speaker, Dr. Hazen, will give the specific results, with statistics, obtained by him by roentgen therapy in skin diseases. We will simply attempt to show the value of this therapeutic agent in the treatment of dermatological affections by enumeration of the conditions in which this treatment is of service, classifying the diseases according to results obtained and comparing, roughly, the results of irradiation with the results obtained with other therapeutic remedies. Because of the condensation of this big subject on account of time and space it will be possible to do no more than to generalize.

It is now pretty generally admitted that the roentgen rays constitute the most useful and successful single remedy we possess for the treatment of dermatological diseases. The only competitor for this distinguished position is radium. In a general way, what one agent will accomplish so will the other. However, roentgen rays save time and expense and can be employed for the treatment of diseases that cover extensive surfaces. They are the more flexible, the more versatile of the two remedies, and therefore they are given the preference in dermatological practice. As a matter of fact, in order to be fully efficient, the dermatologist should possess one or several radium applicators in addition to modern roentgenological apparatus.

That the roentgen rays constitute the most valuable remedy in dermatotherapy, or that the roentgen rays and radium constitute the most useful single agents in the armamentarium of pure dermatology, is shown by the following list of diseases and conditions that are amenable to such treatment, over 80 in number.

LIST OF DISEASES TREATED WITH ROENTGEN RAYS OR RADIUM

Acanthosis nigricans
Acne varioliformis
Acne vulgaris
Actinomycosis
Addison's disease
Angioma, cavernous
Angioma, senile
Angioma, strawberry mark
Blastomycosis
Bromidrosis
Carbunculus
Cheilitis exfoliativa
Cheilitis glandularis
Callositas
Cornu
Dermatitis, infectious eczematoid
Dermatitis exfoliativa
Dermatitis papillaris capillitii
Dermatitis venenata
Epithelioma, basal cell
Epithelioma, multiple benign
Epithelioma, prickle cell
Erythema induratum
Favus, of the scalp
Folliculitis decalvans
Furunculosis
Granuloma annulare
Granuloma fungoides
Granulosis rubra nasi
Hodgkin's disease
Hyperidrosis
Hypertrichosis
Intertrigo
Keloid
Keratosis
Keratosis follicularis
Kraurosis vulvae
Leukemia cutis
Leucoplakia
Lichenification
Lichen planus
Lichen scrofulosorum
Lupus erythematosus
Lupus miliaris disseminatus
Lupus vulgaris
Lymphangioma circumscriptum
Lymphangitis, chronic streptococcic
Lymphogranulomatosis cutis
Neurodermatitis
Nevus pilosus
Onychomycosis
Paget's disease
Parapsoriasis lichenoides
Paronychia
Pernio
Pityriasis rosea
Pompholyx
Prurigo
Pruritus
Psoriasis
Rhinophyma
Rhinoscleroma
Ringworm, eczematized
Rosacea
Sarcoid
Sarcoma, general types
Sarcoma, giant cell
Sarcoma, Kaposi
Scrofuloderma
Sporotrichosis
Sycosis, lupoid
Sycosis vulgaris
Synovial lesions of the skin
Syringoma
Tinea barbae
Tinea tonsurans
Tuberculide
Tuberculosis orificialis
Tuberculosis verrucosa cutis
Verruca vulgaris
Xeroderma pigmentosum

The value of roentgen rays as a therapeutic agent in dermatological practice can be further envisaged by grouping the diseases in relation to susceptibility to this agent and in relation to results obtained with other methods of treatment.

GROUP I

Bromidrosis, localized
Dermatitis papillaris capillitii
Favus, of the scalp
Hyperidrosis, localized
Keloid
Rhinoscleroma
Tinea Tonsurans

Group I comprises diseases in which irradiation offers the sole means of establishing a permanent cure with a reasonable degree of certainty. The preceding statement is not literally true of every

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individual example of the entities in this group.

It is possible to cure some cases of tinea tonsurans with other methods, but considering the disease in a broad sense it must be admitted that irradiation provides the only successful opposition. The same is true of favus of the scalp.

Surgery may be successful in early cases of rhinoscleroma, but in every case, early or late, irradiation causes fairly rapid involution, and recurrences subsequent to complete cure have not been recorded.

There has been considerable controversy relative to the comparative value of irradiation for the treatment of keloid. There is little room for argument. Occasionally a lesion will not return after excision, solid carbon-dioxide treatment, etc. The rule is, however, for the lesion to develop worse than ever after removal by any method that is traumatic in nature. Recurrence after irradiation has not been recorded. Irradiation and surgery must be combined in the case of very large keloids.

Localized hyperidrosis and bromidrosis are placed in this group because persistent, idiopathic examples of these affections can be cured in no other way.

It is possible to cure dermatitis papillaris capillitii with the older methods, especially in the early stage of evolution. Such treatment is, however, very uncertain, disagreeable and unsatisfactory. Irradiation cures the affection promptly and permanently in the early stages. The late keloidal stage may require considerable treatment.

GROUP II

| | |
|---|---|
| Granuloma fungoides (mycosis fungoides) | Sarcoma, Kaposi type |
| Hodgkin's disease of the skin | Sarcoma, giant cell |
| Lymphogranulomatosis cutis | Leukemia cutis |
| | Pruritus |

Group II consists of diseases in which irradiation is the most useful if not the only useful treatment. With the exception of pruritus these diseases are fatal and they all cause suffering. The immediate effect of irradiation may be highly gratifying, even spectacular, but the result is seldom permanent.

Some cases of granuloma fungoides can be controlled for only a year or two, but it is frequently possible to keep the patient free of symptoms for several years, even indefinitely. No other remedy or combination of remedies will accomplish as much. About the same may be said for Hodgkin's disease. The result of irradiation on leukemia cutis and lymphogranulomatosis cutis is not so well known, but results so far observed seem to warrant the inclusion of these affections in this group.

The roentgen rays and radium provide a specific for giant-cell sarcoma. While it is true that the lesions can be excised, they are likely to be too numerous to be handled by surgical methods. The Kaposi type of sarcoma also yields readily to irradiation. There is no other successful method of treatment for this affection unless the lesions happen to be small, not numerous and favorably situated, when they may be destroyed in various ways. It is possible to obtain permanent cures in both types of sarcoma, but before one hazards an opinion it will be preferable to wait until a large number of cases have been observed for at least five or ten years.

That the roentgen rays and radium are excellent antipruritics has long been known. In cases of persistent, localized, essential pruritus of undiscoverable etiology, they are the only remedies that will with a reasonable degree of certainty effect complete relief. The relief may endure for a month, for several months, or for longer periods. Permanent results are uncommon. Occasional failures are noted.

GROUP III

| | |
|---|---|
| Acanthosis nigricans | Kraurosis vulvae |
| Addison's disease | Parapsoriasis, lichenoid type |
| Granulosis rubra nasi | |
| Keratosis follicularis | |

This group represents diseases in which irradiation is reported to have given excellent results, but too few cases have been treated to permit free generalization. There is no known remedy for any of these affections. If further observation supports the results so far recorded, irradiation will be credited with another list of diseases that can not be controlled by any other means.

GROUP IV

Actinomycosis
Angioma, cavernous
Angioma, senile
Angioma, strawberry mark
Blastomycosis
Carbunculus
Callositas
Granuloma annulare
Lupoid sycosis
Lupus miliaris disseminatus
Scrofuloderma
Sycosis vulgaris
Synovial lesions of the skin
Tinea barbae

Irradiation is almost a specific for the diseases of this group and as a rule the result of such treatment is a permanent cure. All of these diseases can be more or less successfully treated with other methods but with less certainty of prompt relief, less certainty of a cure and with less freedom from pain and annoyance. Irradiation can be said to be, as a rule, the method of election for the treatment of these diseases. There must be some selection.

Small angiomata, synovial lesions of the skin and lesions of granuloma annulare can be excised. One treatment with the roentgen rays or radium will permanently cure a synovial lesion of the skin. The same statement is true of the lesions of granuloma annulare, but new lesions are likely to appear from time to time. Surely a treatment that will cause a lesion to disappear as a result of a single exposure of a few minutes to the roentgen rays, is preferable to any surgical method such as excision, desiccation, cauterization, etc.

Strawberry marks disappear very quickly under beta ray applications. A permanent cure can be obtained in one treatment, but in order to avoid sequelae it is preferable to give from two to four treatments, depending upon the size and thickness of the lesions. The result of such treatment is distinctly superior to surgery, solid carbon dioxide or any other method. Surgeons usually hesitate to excise cavernous nevi because of the danger of hemorrhage, infection and deformity or disfigurement. The lesions are often located in regions where it is difficult if not impossible to employ any surgical method. The injection method has not given satisfaction. Solid carbon dioxide has given good results in small, suitably located lesions. Irradiation, however, has given better results than all other methods combined. With care and patience it is possible, without injury to the skin, to completely efface an extensive cavernous angioma which involves most of the face and mouth, which is so extensive and disfiguring as to constitute a monstrosity, and which could not be as successfully treated with any other method or combination of methods.

The annoying callositas on the plantar surface of the feet can be, with difficulty, eradicated by excision, by curettage and vigorous cauterization, by desiccation, the actual cautery, etc. The majority of these lesions can be permanently cured with from one to four applications of the roentgen rays or radium, without pain or inconvenience. Therefore irradiation is the method of election.

A carbuncle may be aborted if treated sufficiently early with an intensive dose of filtered radiation. If well developed, the lesion must be incised. Basing an opinion upon what has been reported in the literature it can be said that the roentgen rays or radium should be used if possible in every case of carbuncle.

The results of irradiation in unselected cases of cutaneous blastomycosis and actinomycosis have been superior to those obtained by any other treatment so far used. Iodide of potassium and other internal remedies are very uncertain in these affections. Small lesions can be destroyed with the curette and cautery. It is difficult and often impossible to cure extensive and deep seated lesions without the aid of the roentgen rays or radium. Unfortunately irradiation is not always successful.

Lupoid sycosis can be cured quickly and permanently with the roentgen rays or radium. Other methods are uncertain, painful and disfiguring.

The lesions of lupus miliaris disseminatus have been found very susceptible to irradiation. They can, of course, be removed with the cautery. The fact that they are often numerous and that they can be removed promptly without pain or disfigurement with the roentgen rays or radium, makes such treatment the method of election. Hygiene, fresh air, sunlight, liberal diet, etc., and tuberculin will not infrequently have to be combined with

irradiation in order to obtain a permanent result.

Scrofuloderma, because of the excellent and reasonably certain results obtained with the roentgen rays and radium, should always be irradiated if possible. In this disease, however, irradiation alone should not suffice. These little patients must receive, if possible, the benefit to be derived from fresh air, good food, sunshine, etc. The literature contains good reports of heliotherapy, actinotherapy and ultraviolet therapy in this disease, but the concensus of opinion favors irradiation.

Dermatologists agree that irradiation is the best and very often the only successful treatment for widespread, persistent sycosis vulgaris. Often the result is spectacular but occasional cases are recalcitrant. Not infrequently good results are obtained with autogenous and stock vaccines, by pulling out the infected hairs, together with the local use of antiparasitic remedies. While irradiation is the method of choice it should be combined with vaccine treatment, sanitation and non-irritating topical remedies.

The lesions of tinea barbae can be cured with one application of the roentgen rays or radium. No other treatment is as efficacious or as painless. Nevertheless, the affection can be cured by other means.

GROUP V

| | |
|---|---|
| Epithelioma, basal cell | Paget's disease |
| Erythema induratum | Sarcoid |
| Keratosis | Tuberculosis orificialis |
| Leukoplakia | Tuberculosis verrucosa cutis |
| Lupus vulgaris | Xeroderma pigmentosum |

Excellent results can be obtained with irradiation alone in the diseases of this group. For the best results the cases must be selected and very often it is necessary to combine irradiation with surgery or other methods of treatment. These diseases can be cured with treatment other than the roentgen rays or radium.

Irradiation gives as high a percentage of permanent cures in unselected basal-cell epithelioma as does surgery. Because of the freedom from pain, non-interference with vocation, good cosmetic results and ability to reach inaccessible locations, it would seem that irradiation might be considered the method of election.

Irradiation and surgical methods share about equal honors in the treatment of keratosis. Beta radiation appears to be the choice for arsenical and roentgen-ray keratoses. The nevoid keratoses should be curetted and the horny layer removed from senile and seborrheic keratoses before irradiation. About the same results may be obtained with curettage and caustics, excision, desiccation, etc., but scarring is likely to be more pronounced.

Beta radiation is often efficacious in small patches of leukoplakia, seldom in large patches. It is possible that the actual cautery combined with oral hygiene is preferable in most cases of leukoplakia.

In lupus vulgaris the result of irradiation depends upon the clinical type. Irradiation alone is to be preferred in most cases of hypertrophic and ulcerative lupus. The roentgen rays and radium are not as efficacious as is a combination of irradiation, surgical methods and tuberculin in atrophic lupus. In general, the roentgen rays and radium are more successful in lupus vulgaris than is ultraviolet ray therapy as employed in this country. The statistics reported from European Finsen institutes are superior to those obtained with the roentgen rays or radium.

As a rule, the lesions of erythema induratum involute subsequent to from one to three applications of filtered radiation without any other treatment. Quicker results are obtained with irradiation combined with rest and hygiene. While no other remedy will effect such prompt cure of individual lesions irradiation alone will not prevent the development of new lesions.

There is some difference of opinion about the efficacy of irradiation in the Boeck type of sarcoid. Our results indicate that it is the method of choice. Others have not obtained good results. In a few years this question will be decided. Evidence at hand in the case of sarcoid of the Darier-Roussy type warrants the belief that irradiation is an extremely valuable and successful treatment. As in erythema induratum these patients should also receive the benefit of hygiene, fresh air, tuberculin, etc.

Caution must be exercised in selecting treatment for Paget's disease. If the mammary gland is involved surgery is indicated. The results of irradiation are splendid if there is no involvement of the deep tissues.

Excellent results have been obtained with irradiation in tuberculosis orificialis, but the method has not replaced surgery, excision, surgical diathermy, actual cautery, etc.

Small lesions of tuberculosis verrucosa cutis will disappear as a result of a single exposure to the roentgen rays or radium. Large lesions are often very stubborn. In some cases surgical methods are preferable while in other cases irradiation is indicated.

Xeroderma pigmentosum as a disease is incurable, but the keratoses and epitheliomata can be cured with the roentgen rays, radium, or surgically.

GROUP VI

| | |
|---|---|
| Acne varioliformis | Cornu |
| Acne vulgaris | Lymphangioma circumscriptum |
| Cheilitis exfoliativa | Verruca vulgaris |
| Cheilitis glandularis | |

In this group the diseases can be cured with regular dermatological treatment or with irradiation. The latter, however, gives the best comparative results.

One should hesitate before venturing a dogmatic opinion regarding the comparative value of irradiation and topical remedies in the treatment of acne varioliformis. More evidence is needed. It would seem, however, from the evidence at hand, that the eruption involutes more rapidly and that recurrences are less frequent subsequent to irradiation than after any other treatment.

There is no question but that acne vulgaris can be cured more quickly and with greater certainty with irradiation than with any other treatment. However, there are clinical types of this disease in which irradiation is not indicated; and not infrequently cases, in which such treatment is apparently indicated, will not get well without attention to the gastro-intestinal tract, the genito-urinary tract, the general health, etc.

Cheilitis exfoliativa and cheilitis glandularis are not common diseases and the evidence so far collected will not permit of dogmatic opinion. They are stubborn affections. The most that can be said at present is that irradiation appears to be superior to any other treatment.

Soft corns can be permanently cured with one application of the roentgen rays or radium, especially with beta rays. Hard corns are more stubborn. It is doubtful if any other treatment is as efficacious in stubborn cases.

Lymphangioma circumscriptum as a rule yields readily to beta radiation. Such treatment is preferable to solid carbon dioxide, caustics, etc.

It is our experience that about 75 per cent of common warts will permanently disappear as a result of from one to three applications of the roentgen rays. We prefer such treatment to desiccation, application of acids, etc., in most cases.

GROUP VII

| | |
|---|---|
| Onychomycosis | Paronychia, chronic |

In these two conditions irradiation is uncertain in its action, but prompt and permanent cures are obtained in some cases. All methods of treatment are uncertain in these diseases.

GROUP VIII

| | |
|---|---|
| Furunculosis | Rosacea |
| Pityriasis rosea | Sporotrichosis |

Irradiation is useful, even curative, in the affections in this group, but equal and even superior results can be obtained by other forms of treatment.

Irradiation is very valuable in chronic furunculosis when the boils keep developing in localized areas. All cases should, however, receive general medical attention.

Pityriasis rosea is a self-limited affection, the eruption is usually not annoying and involution occurs in a few weeks. Occasionally, however, the eruption is very severe and the disease may endure for several months. Those who have had experience with the roentgen-ray treatment of pityriasis rosea aver that the eruption disappears very quickly when irradiated.

Rosacea, when associated with acneiform lesions and seborrhea, improves markedly when irradiated. It is not scien-

tific, however, to depend upon irradiation in this affection, as it is usually caused by faulty diet and visceral disturbances.

Sporotrichosis can be cured by the ingestion of potassium iodide. Irradiation hastens involution and is of value in obstinate cases.

GROUP IX

Epithelioma, prickle cell
Hypertrichosis
Nevus pilosus
Rhinophyma
Sarcoma, general types

The diseases in this group may be cured with the roentgen rays or radium, but as a rule better results can be obtained with other methods of treatment.

Prickle-cell epithelioma should be regarded as a surgical disease. Irradiation, however, has its place. Very early lesions may be cured and occasionally brilliant results are obtained in inoperable cases.

Electrolysis is preferred by the majority of experts in hypertrichosis and nevus pilosus. Irradiation is indicated in selected cases.

While irradiation is of some value in hypertrophic rosacea and rhinophyma, the majority of dermatologists depend on topical remedies, multiple scarification, etc.

Brilliant results have been obtained with the roentgen rays and radium in cases of lymphosarcoma and even in melanoma and disseminated sarcomatosis cutis. Sarcoma is considered a surgical disease, but irradiation is of service in selected cases and in inoperable cases.

GROUP X

Dermatitis exfoliativa
Dermatitis venenata
Eczematized ringworm
Infectious eczematoid dermatitis
Intertrigo
Lichenification
Lichen planus
Neurodermatitis
Pompholyx
Psoriasis

In this group of diseases irradiation is often of great service, especially in obstinate cases. It is doubtful if any other treatment will effect such prompt relief from itching and such rapid involution of generalized lichen planus. A similar statement can be made for many members of the eczema group. While irradiation will apparently produce a permanent cure in individual examples of the diseases in this group, such treatment, in order to obtain good average results, should be subordinate to intelligent dermatological management, and employed only when indicated.

GROUP XI

Lupus erythematosus
Prurigo
Tuberculide

For the diseases of this group irradiation is of service in some instances. Occasionally beta radiation will effect a brilliant temporary result in lupus erythematosus. Roentgen radiation may be employed to relieve the intense itching of prurigo temporarily and to hasten involution of the eruptions known as tuberculide.

GROUP XII

Folliculitis decalvans
Lichen scrofulosorum
Epithelioma, multiple benign
Pernio
Streptococcic lymphangitis, chronic
Syringoma

The roentgen rays and radium have been used with success in the treatment of these affections, but there has not been enough experience to estimate the true value of irradiation.

GROUP XIII

Angioma
Cornu, soft
Keratosis
Kraurosis vulvae
Leukoplakia
Lupus erythematosus
Lymphangioma

This group consists of diseases in which beta rays appear to be more efficacious than gamma rays or the roentgen rays.

# THE ROENTGEN-RAY TREATMENT OF DISEASES OF THE SKIN*

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THE honor of the invitation to read a paper upon the treatment of cutaneous diseases by means of the roentgen ray is much appreciated by me. The paper will deal exclusively with the results obtained upon private patients, and no attempt will be made to cover the very extensive literature of the subject, this being covered in MacKee's book.[1]

The technique employed has been that advocated by MacKee, namely the use of modern apparatus and the invariable measuring of doses, at first by means of pastilles and later by MacKee's arithmetical formula.

## SUPERFICIAL MALIGNANCY[2]

One case of rapidly growing sarcoma was apparently stimulated rather than benefited.

But one case of malignant mole was treated and while the original condition was cured general metastases developed within a year.

One interesting case of xeroderma pigmentosum was followed from the time the child was three months old until death at four years of age. At the early age of two years malignant tumors began to appear on the face and neck. More than twenty of these were entirely dissipated by the roentgen ray, but eventually two rapidly growing lesions developed which were absolutely not influenced by the ray and death resulted from these.

As regards basal-celled cancer 104 persons affected with a total of 147 basal-celled cancers were treated. The results. of these have been as follows:

| | |
|---|---|
| Well over three years | 16 |
| Well over two years | 17 |
| Well one year | 81 |
| Relapses cured | 4 |
| Relapses healed | 2 |
| Not cured | 15 |

Of the 15 cases which were not cured, 6 were hopeless from the start because of their large surface and deep involvement. Three patients received insufficient treatment because of the failure to attend regularly. One case had had large amounts of fractional treatment. In three instances the cartilage of the ear was deeply invaded and none of these patients responded to radiation although all were cured by the cautery. My experience has been that where the cartilage is invaded the patient does not respond nearly so well to radiation as might be expected. The results obtained in this series of cases are practically indentical with those from good surgery.[3]

Fifteen patients with prickle-celled cancer were treated. Four cases were permanently cured. Three healed under treatment, although it is still too early to say that the patients are well, and eight were not in the slightest degree influenced. The diagnosis in each of these cases was confirmed by pathological examination and it might be added that in one-half of the basal-celled cancers a similar examination was made.

It is unfortunate that we have no extensive statistics showing the comparison between cases treated with and without filtration, or showing the difference between the efficacy of hard and soft rays. However, in three instances no effect had been obtained by excellent roentgenologists who had employed from 1 to 3 mm. of aluminum for filtration and yet all of these cases responded to the unfiltered ray. At the present time I should be much inclined to feel that superficial cancers will yield much more rapidly to unfiltered than to filtered doses and that the very powerful types of apparatus that are now being developed will have no effect upon the prognosis of skin cancer. The technique in all cases of superficial

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cancers was as follows: Focal skin distance, 9 inches, 7½ inch spark gap, 4 ma., time, two minutes and fifteen seconds to two minutes and thirty seconds, no filter, intervals about three weeks. However, where there was marked induration various degrees of filtration were employed.

The cosmetic results of treatment were excellent. In about 15 of my cases a slight amount of telangiectasis resulted. This sequela is much less likely to result from three or four very intensive doses over a small area than from the same number of considerably smaller doses over a larger area.

### KERATOSES

A large number of keratoses have been treated. There has not been time to review all of the case histories, but we have looked over 48 of them, comprising a total of 101 lesions, and have found only one instance where a cure did not result.

Inasmuch as the majority of these lesions occurred upon dry skin and upon those persons who have been much exposed to the actinic rays of the sun, there has been some hesitancy in the use of the roentgen ray in this disease. However, this list comprises a considerable number of patients who have been well from four to ten years, and even now the skin is absolutely soft and pliable. It has taken from one to three treatments to effect a cure. The technique employed was as follows: Focal skin distance, 9 inches, 7½ inch spark gap, 4 ma., time, one miuute and thirty seconds to one minute and forty-five seconds, no filter. In no instance have there been unfavorable complications.

### BENIGN TUMORS

Ten cases of keloid were treated. In all instances a complete flattening was secured. One keloid 3 by 4 inches in surface measurement and at least ¾ of an inch in thickness was completely dissipated. In three instances some slight telangiectasis resulted. The technique was as follows: Focal skin distance, 9 inches, 7½ inch spark gap, 4 ma., time, one minute and thirty seconds to one minute and thirty-five seconds, no filter, intervals of three weeks. From three to ten treatments were necessary to effect a cure, the number of treatments depending upon the size of growth.

It is interesting to note that in our experience at Freedman's Hospital we had the greatest difficulty in influencing keloids in the negro race unless a second degree dermatitis was produced. One of the 10 cases was a Filipino with comparatively dark skin, and her keloid, more than 1 inch in diameter and certainly more than ¼ inch in elevation, required eight treatments before it disappeared. This is considerably more than similar growths in lighter patients require.

One case of von Recklinghausen's disease was observed over a sufficient space of time to warrant any conclusions. In this case no attempt was made to treat all the lesions, but simply to establish a suitable working basis for the use of the roentgen ray. Both filtered and unfiltered treatments were given to similar individual lesions and it was found that the unfiltered ray produced much the better results. In order to flatten out the tumor which was about ½ inch in diameter, three treatments with the following technique were given: Focal skin distance, 9 inches, 7½ inch spark gap, 4 ma., time, one minute and thirty seconds, no filter, intervals of three weeks.

One case of adenoma of the sweat glands, about ¾ of an inch in diameter and proven by histological examination, was cured by two exposures of 1½ H units each.

### WARTS

From the standpoint of the roentgenologist warts may be divided into four groups. First, the ordinary verrucæ vulgares of glabrous skin; second, plantar warts; third, warts of the lips; and lastly, flat warts. Unfortunately, there has not been time to review the case histories of the first group, but the results have been somewhat discordant. In about 90 per cent of the cases the lesions have been made to disappear after from one to three treatments with the following technique: Focal skin distance, 9 inches, 7½ inch spark gap, 4 ma., time, one minute and thirty seconds to one minute and fifty seconds, no filter, intervals of two to three weeks. But in exceptional instances four to six treatments

were required, and in at least 6 cases we have been absolutely unable to effect a cure. In all cases only the wart and not the normal skin is exposed to the ray. Speaking purely from memory, it can safely be said that at least 150 cases of these warts have been handled by means of the roentgen ray.

Twenty-four cases of plantar warts have been treated.[4] All these were cured with the exception of one, and this we were absolutely unable to influence despite very heavy treatments. The technique was as follows: Focal skin distance, 8 inches, 7½ inch spark gap, 4½ ma., time, one minute and thirty seconds to one minute and fifty seconds, no filter, intervals of two to three weeks.

Six cases of warts of the lips were treated, all successful. From two to three treatments were given. The same technique was employed as in ordinary warts of the skin.

The majority of observers believe that flat warts cannot be cured by means of the roentgen ray, and our experience has been that only in exceptional instances do they respond well. We have handled 9 cases with three cures. The technique is the same as that for other warts.

It is probable that an unfiltered ray should invariably be used for verrucæ inasmuch as a pathological study of these little growths shows them to be extremely superficial. One very interesting fact is that four times I have considered a lesion to be an ordinary wart, and later, to my intense chagrin, found that in reality it was cancerous in nature, and that the small amount of treatment had acted as a stimulant. None of the textbooks mentions an ordinary wart as an antecedent of cancer, but it seems worth while to warn the profession that an apparently perfectly harmless wart may in reality prove to be a malignant tumor.

### ECZEMA

Eczema is an expression used for a large number of skin diseases.[5] A number of these entities can clearly be separated. The most important of these are as follows: Neurodermatitis, infantile eczema, irritant dermatitis, urticarial eczema, infectious eczematoid dermatitis, and last and by no means least, eczema of the hands and of the feet, which is now known to be a ringworm infection in many instances. It is possible that in a few years the expression "eczema" will be as obsolete as the term "rheumatism" should be at the present day. At times, practically all of these conditions can be benefited by means of the roentgen ray, although the ringworm cases are much more readily cured by proper local medication. The same may be said of infectious eczematoid dermatitis. The conditions, however, can usually be handled with much success.

My associate, Dr. Eichenlaub, in his paper, "The Roentgen-Ray Treatment of the Eczema Group,"[6] reviews 100 unselected cases and finds that an average of 2.9 treatments were required to effect a cure, that the average duration of the disease was 135.50 weeks, and that the average time required to cure was 7.6 weeks. In this series of cases there were four failures. In many instances the rapidity of the recovery has been most startling to the patient. The technique was as follows: Focal skin distance, 9 inches, 7½ inch spark gap, 4 ma., time, thirty-five seconds, no filter, intervals of ten days. As an accessory we have frequently employed the well-known calaminė lotion.

We have treated one case of infantile eczema in which all medicinal treatment failed, and there was a marked benefit by using the roentgen ray, but the case was not entirely cured. Practically the same technique was employed as for other cases of eczema.

Fifteen cases of seborrheic dermatitis of the glabrous skin improved promptly under the roentgen ray. The technique is the same as for the eczema group, just mentioned.

Three cases of vegetating dermatitis were cured in from three to five treatments. The technique was as follows: Focal skin distance, 9 inches, 7½ inch spark gap, 4 ma., time, one minute and fifteen seconds to one minute and forty seconds, no filter, intervals of two weeks. There were no failures in this series.

### ACNE VULGARIS[7]

One hundred and seventy cases of acne vulgaris have been carefully followed.

In addition to the roentgen ray treatments the majority of the acne patients have cut down their carbohydrate intake, chocolate has been eliminated, and at times a mild astringent lotion has been employed. It has been the custom to start the majority of these patients upon the usual medicinal treatment: arsenic internally, dietary measures, the use of astringents, and the removal of black heads, but it has been found that this treatment is effective in not over one-third of the cases. The results of roentgen therapy are as follows.

TABLE I

| Results | Juvenile | Papulo-pustular | Indurata | Back | Total |
|---|---|---|---|---|---|
| Improved | .. | 17 | 3 | .. | 20 |
| Cured | 2 | 41 | 20 | 4 | 67 |
| Cured bad relapses | .. | 3 | .. | .. | 3 |
| Cured mild relapse | 3 | 28 | 5 | .. | 36 |
| Cured question as to relapse | 2 | 26 | 6 | 3 | 37 |
| Failure | .. | 6 | 1 | .. | 7 |
| | 7 | 121 | 35 | 7 | 170 |

Table II will show how promptly they improved.

TABLE II

| No. Doses | Juvenile | Papulo-pustular | Indurata | Back | Total |
|---|---|---|---|---|---|
| 1 | .. | 13 | 6 | 2 | 21 |
| 2 | 2 | 32 | 10 | 3 | 47 |
| 3 | 4 | 39 | 11 | 5 | 59 |
| 4 | 1 | 22 | 4 | .. | 27 |
| 5 | .. | 5 | 3 | .. | 8 |
| 6 | 1 | 2 | .. | .. | 3 |
| 7 | .. | 2 | .. | .. | 2 |
| | 8 | 115 | 34 | 10 | 167 |

As regards the duration of treatment, there are two different ways in which the cases may be handled. They may be kept under observation for at least one year, giving the patients treatment with the following technique, biweekly: Focal skin distance, 9 inches, 7½ inch spark gap, 4 ma., time, thirty-five seconds, no filter. After five to eight treatments are given, the time between treatment is gradually increased until bimonthly treatments are given. The second method is to clear up the attack and then each recurrence as it may appear. It should be especially mentioned that the recurrences are usually very much milder than the original attack.

In four instances patients had telangiectases. One of these was due to a deliberate overdose given in a successful attempt to stop a very severe acne indurata, one to the slipping of lead foil, and in a third instance the patient had had previous roentgen-ray treatment. In one case there has been an unpleasant amount of dryness. It has been suggested that cases of acne treated with roentgen rays will sometimes show deeper pits than untreated. However, the general consensus of opinion among competent dermatologists is that such is not the case; and our own experience bears this out. It is not infrequent to find that, owing to the skin becoming dryer than normal, an irritant dermatitis from the use of furs, cosmetics, and soap and water may be rather easily set up. Many brunettes show a marked tendency toward pigmentation, but we have never seen a permanent example of this. Freckling is very common. A number of patients have

felt that the growth of superfluous hair is stimulated by roentgen therapy, but I do not believe this is possible. Superfluous hair and acne are very prone to travel hand in hand, both being due to over activity of the pilosebaceous gland apparatus. In addition, the growth of superfluous hair is usually directly under the chin where practically no treatment is received.

In conclusion, it might seem that the roentgen-ray treatment of acne affords much the quickest and surest method of controlling this disease.

### ROSACEA

The roentgen-ray treatment of rosacea has not proven nearly so satisfactory as that of acne. Nineteen cases of this condition have been treated. Of these, 4 were cured and 7 were improved; out of the remaining cases a few of them improved somewhat only to relapse severely again. It has been found necessary to employ an entirely different technique from that used for acne. The technique which we have found most beneficial is as follows: Focal skin distance, 9 inches, 7½ inch spark gap, 4 ma., time, from ten to twenty seconds, no filter, intervals of seven to ten days.

It is worth while mentioning that some of the best dermatologists feel that the roentgen ray will do much for rosacea; but this has not been the experience in my office despite the use of many different techniques.

### PSORIASIS

Twenty-six cases of psoriasis have had their histories carefully reviewed. Of these, 22 were very much improved. One showed little improvement, and 3 cases were made very much worse. In two of these instances there was a considerable temporary improvement at first, but later a more or less complete generalization of the disease developed, and a third case was made worse by the first treatment. Practically all the cases showed relapses, the longest interval of freedom observed being one year. The average time of relapse was about two months. As a general rule the relapses were just as severe as the original condition. In addition, I am rather inclined to believe that sunlight does not have as much beneficial effect upon those patients who have had roentgen-ray treatment as it has upon those who have not been so treated.

Owing to the fact that psoriasis is pathologically an extremely superficial condition, it has been my practice to use rather soft rays, and I am fairly well convinced that soft rays are much more beneficial than are hard rays. The technique was as follows: Focal skin distance, 9 inches, 6 inch spark gap, 7 ma., time, from forty-five to sixty seconds, no filter, intervals of two to three weeks.

In conclusion it might be said that while the roentgen ray will usually clear up a case of psoriasis in an easy and cleanly fashion, it should not be employed as a routine, for relapses are practically sure to follow, and the continued use of the roentgen ray over a period of years is hardly to be advised in the present state of our knowledge, particularly if it is more or less generalized. Exposure to sunlight is unquestionably safer and usually just as efficacious, and the proper rubbing in of chrysarobin ointment is not to be despised. The later work of using stimulating doses to the thymus gland sounds rather promising, but as yet must be regarded as merely on trial.

### LICHEN PLANUS

Nine cases of lichen planus have been treated with marked benefit in 8 cases. The ninth case was an old hypertrophic affair which at the present time is responding slowly, but definitely, to treatment. The relief from itching in all cases is markedly improved. While mercury has been used in conjunction with all cases, still the rayed areas have responded very promptly. The technique is the same as for eczema, although it is probable that the hypertrophic cases should receive more than others.

### LUPUS ERYTHEMATOSUS

There are many dermatologists who feel that the use of the roentgen rays are inadvisable in lupus erythematosus. I have seen a number of cases where the condition was unquestionably aggravated

by comparatively light doses, and it is not unusual to find other cases in which no benefit resulted. However, I have had one case in which the whole face was involved, which resisted all other types of treatment and yet was cured by the roentgen rays. The technique was the same as that employed in the treatment of acne. Of course a stimulating dose should never be employed except in a chronic or subacute type of this condition, the acute type almost invariably being made worse. The use of carbon-dioxide snow or the ultraviolet rays is preferable.

### DISEASES SUPPOSEDLY DUE TO THE TUBERCLE BACILLUS

Two cases of tuberculides have been handled with very gratifying results, using one treatment with the following technique: Focal skin distance, 9 inches, 7½ inch spark gap, 4 ma., time, one minute and thirty seconds, no filter, which sufficed to resolve the lesion in from one to three weeks.

Scrofuloderma usually does very well. Two cases recovered under three treatments. Owing to the fact that scrofuloderma is usually associated with tuberculous glands very heavy filtered treatments were given.

One case of tuberculosis verrucosa cutis, of many years, duration was cured. The technique was as follows: Focal skin distance, 9 inches, 7½ inch spark gap, 4 ma., time, one minute twenty-five seconds, no filter, intervals of three weeks. Four treatments were necessary.

My results in the treatment of lupus vulgaris with the roentgen rays have not been satisfactory. This is in marked contrast to the claims of many authors. However, if one talks with dermatologists, one will find that they are not particularly enthusiastic as regards treating many cases of lupus with the roentgen rays. As a matter of fact, the pathology of a long-standing case of lupus vulgaris is very similar to that of a healed roentgen-ray dermatitis, and one would hesitate for a considerable space of time in treating the last mentioned condition with the roentgen rays. In 2 cases under my observation severe third degree dermatitis resulted from comparatively light treatment. The technique employed was: Focal skin distance, 9 inches, 7½ inch spark gap, 4 ma., time, one minute and fifteen seconds, no filter, intervals of three weeks. However, in the early cases, before much scarring takes place, the results may be excellent. Out of 7 cases treated there have been three cures and 4 were improved. The 3 cured cases were all very early ones. In addition to the 7 cases, one case of hypertrophic lupus is still under observation and is being benefited by the roentgen rays.

One case of Boeck's sarcoid was cured by 2 treatments, although the disease had existed for years.

### DISEASES DUE TO STAPHYLOCOCCI

Two cases of sycosis non-parasitica were treated with epilating doses. Unfortunately in both cases the fields of exposure were not entirely correct and a few hairs remained which speedily became involved, necessitating further treatment. There can be no question, however, but that the roentgen ray should be used in such cases.

Six cases of folliculitis of the back of the neck have been handled with epilating doses, in every instance with admirable results, although in 2 of the cases a sufficient number of exposures had to be given to produce a permanent alopecia.

Two cases of paronychia were treated with absolutely no results.

### DISEASES DUE TO FUNGI

Tinea tonsurans is a most unsatisfactory condition to treat by any method except by the roentgen rays. Some eight years ago I published a series of 225 cases of this disease so treated and to date probably about 350 have been handled. The technique was as follows: Focal skin distance, 9 inches, 7½ inch spark gap, 4 ma., time, one minute and twenty-five seconds, no filter. One treatment only is required. The hair is cut short and a line drawn down the center of the scalp from the forehead hair line to the occipital hair line. The middle of this line is determined by the eye and marked either with a skin pencil or by putting a small piece of adhesive on it. This is Point B. Just 5

inches anterior to this point another mark is made—Point A—and just 5 inches posterior to point B is another mark—Point C. On the sides of the scalp and 5 inches equidistant from points A, B, and C we have D and E on the right and left sides of the head, respectively. The tube is centered over each of these points, care being taken that each exposure is given at right angles to the others, and that the required dose is given. The reason for this technique is given very fully in MacKee and Remer's article.[9] Of course, the eyes, ears and shoulders must be carefully protected with lead foil when any of these parts are subjected to the rays.

It is not necessary that every hair in the head be removed: the falling of the diseased hairs and the majority of the others is sufficient to effect a cure provided that the scalp be kept covered with an antiparasitic preparation. Where there are but one or two small spots, it is not necessary to treat the entire scalp if the child is subject to careful and intelligent supervision, but in the majority of instances it is better to remove all the hair at one sitting, for the falling hairs are almost certain to infect other portions of the scalp. If it be decided to treat but one spot, it is best to cut a piece of adhesive plaster that will fit this spot and keep it adhering to the hair or else replace it as soon as it comes off. The hair will come off with the adhesive and not be scattered. Ordinarily, the defluvium is complete in about three weeks and the new hair returns in from six to twelve weeks after falling. In only one case was there a recurrence, although in the various homes there were many instances of reinfection on the same patients.

As regards untoward results we have had 2 cases of permanent alopecia. One of these was due to the stopping of the clock during treatment and the second was due to the child moving so that there was some overlapping of the field of exposure. In the children from one home, too strong an ammoniated mercury ointment was used after radiation and the result was a wonderful crop of boils. The hair does not always return the same color; in one young child with beautiful red hair the new hair was brown. Unfortunately, this was a case in which a partial epilation was done. At times the texture of the new hair is not the same as that of the old. For instance, we have seen a kinky-headed negro secure some beautiful straight hair, for the time being at least, as the result of the roentgen-ray epilation. These facts are additional arguments against partial epilation. In 5 cases there has been a considerable quantity of white hair as the result of this treatment. Analysis of these cases has shown that in each instance the child received at least three different treatments at varying intervals, made necessary because of reinfection. So far as I know this observation has not previously been made.

In conclusion it may be said that the use of the roentgen ray offers much the quickest and surest method of permanent cure in tinea tonsurans, and that with correct technique it is absolutely safe, provided that a case does not have to be epilated frequently as might occur in an institution.

Two cases of ringworm of the beard have been treated with epilating doses of roentgen rays, with immediate permanent cure.

Five cases of ringworm of the nail have been treated, 3 with no results and 2 with cures. In no instance did the nail fall. The technique was as follows: Focal skin distance, 9 inches, 7½ inch spark gap, 4 ma., time, forty-five seconds, no filter, intervals of two to three weeks.

### HYPERTRICHOSIS

I flat-footedly do not believe in attempting to remove superfluous hair by the roentgen ray. In the vast majority of instances a sufficient amount of roentgen rays to atrophy the hair follicles permanently, is almost certain to cause an atrophy of the corium, and results in some permanent wrinkling, and even telangiectasis may result. However, this method is possibly permissible beneath a very prominent chin where such wrinkling would not be noticed. In 4 cases the attempt has been made to remove hair from small hairy moles by means of the roentgen ray. However, it was soon learned that this was not easily done. The technique necessary to effect a permanent cure was as follows:

Focal skin distance, 9 inches, 7½ inch spark gap, 4 ma., time, at least two minutes and fifteen seconds, no filter.

### HYPERHIDROSIS

Considerable difficulty has been experienced in curing hyperhidrosis by means of the roentgen rays. Apparently a large number of heavy exposures are required, and at the present time I am not prepared to recommend an exact technique, although I am sure results can be obtained.

### PRURITUS

Eight cases of pruritus of the genitalia have been treated. Two were complete failures, 2 were temporarily improved and the other 4 were greatly improved. It seems too much to expect the roentgen rays permanently to cure this condition, which in the majority of instances is probably due to a psycho-neurosis. The technique was as follows: Focal skin distance, 9 inches, 7½ inch spark gap, 4 ma., time, forty-five seconds, intervals of two weeks.

### UNUSUAL CONDITIONS

One case of granuloma annulare was cured by two exposures. One case of mycosis fungoides has likewise been improved. The tumors resolve very rapidly under comparatively light treatments. However, so far as I can learn, no case of this condition has been permanently cured by means of the roentgen rays.

### CONCLUSIONS

Roentgen rays are probably the most useful single therapeutic agent that the dermatologist possesses today. It is of the greatest value in both malignant and benign tumors, keratoses, warts, eczema, acne, lichen planus, some forms of tuberculosis, sycosis and folliculitis of the back of the neck, tinea tonsurans, tinea barbae, some cases of pruritus, granuloma annulare and mycosis fungoides.

At the same time a word of warning must be issued, for since the war scores of physicians with totally inadequate training are rushing into roentgen-ray therapy and it is certain that some disastrous results will follow. In no case should an erythema dose be administered to the skin, except after careful consideration of malignancy. In addition, it should always be remembered that an erythema dose over a large area of skin is much more apt to result in disastrous sequelae, especially telangiectasis than is the same size dose over a small area. Treatments should never be continued for more than six months, except under very special circumstances.

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# SUPERFICIAL MALIGNANCIES*

BY CHARLES F. BOWEN, M.D.

COLUMBUS, OHIO

Every case of superficial cancer can be cured if seen while it is still a localized disease. Whether or not all cases are cured is another question. What I want to do in this paper is to give some of the reasons why I have not cured all my cases and to describe the methods used at the present time, which are almost 100 per cent efficient.

Twenty years ago we treated our epitheliomas every day or every other day, with mild roentgen ray without filters. If the cancer did not heal, it was because the patient got tired of coming for the treatments, or else we produced a roentgen ulcer, which, of course, could not heal under continued roentgen-ray treatments.

A little later we began to understand the ill effects of overtreatment and began to use filters. This led to the time when we gave our patients heavier treatments farther apart, say once a week. We soon had a technique which would cure practically all the cases which stayed with us.

About three years ago, while checking my results over a considerable period, I was surprised to find that a considerable number of patients took only one, two or three treatments and then failed to return. This amounted to two or three cases per week. Practically all these cases could have been cured if only they had taken a sufficient number of treatments. Letters were written to a great many of them and to their referring physician, requesting the reasons for discontinuing treatment. We soon discovered that the majority of them stopped treatment because they did not see any improvement. They had heard so much about burning out cancers that they were frankly disappointed when they did not see some decided change after one or two treatments. A number of patients wrote that their cancer gradually got well of its own accord, after stopping treatment, refusing, however, to give the roentgen ray any credit. Others were so disappointed at the apparent failure that they refused to take any kind of treatment and died the usual cancer death.

The cause of failure, then, of the majority of the cases, was the failure of the patient to continue treatment. We are not surprised at this when we consider that the majority of cancer patients are old and sometimes feeble. On the other side of the case, we have the personal equation of the operator. This I can sum up as follows: Failure to realize the extent and seriousness of the case; failure to give sufficiently hard or severe treatments at the beginning of the series; failure to stop treatments after the cancer cells are destroyed, allowing the ulcer to heal.

This led us to devise ways and means of curing our patients with fewer and fewer treatments. We tried massive doses and various modifications of this method, but there were always a certain number of cases which would not respond to treatment and would get away from us.

Radium was used with about the same results as with the roentgen ray, always leaving a certain number of cases which would not respond to treatment. Electric coagulation and fulguration were used with about the same results. This led to the conclusion that no one method would cure all cases. The use of escharotics in the form of paste, liquid or what not, has long since been discarded, as destroying too much healthy tissue, being entirely too painful to the patient, and on the whole, being too unscientific.

The three remedies, or agents, at hand, which offered the most hope, were the roentgen rays, radium and electric coagulation. These three, in proper combination, I believe will kill any cancer within reach.

We proceed somewhat as follows: All the growth projecting above the normal skin is destroyed by electric coagulation, after injecting novocaine with a little adrenalin. The burnt tissue is carefully

*Read at the Twenty-Second Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Washington, D. C., Sept. 27–30, 1922.

curetted away and the base of the ulcer thoroughly heated with the electric current. The roentgen rays are then used to destroy any cells which were lying deeper in the tissues. At least 50 ma. minutes of unfiltered rays are used over an area a little larger than the ulcer.

Any of the cancerous tissue which is covered by normal epithelium, is exposed by the electric coagulation. The main object is to expose all the cancer tissue and form an open ulcer.

This, in short, has been our method of attacking these cancerous growths involving the skin.

PLATE 1. Cancer of the corner of the eye before treatment, after excess tissue was removed by electro-coagulation, and after healing had taken place. One intensive treatment was given immediately following the electro-coagulation.

PLATE 2. Epithelial carcinoma on the face before treatment, after electro-coagulation and end result. The excess tissue was burned down to the skin level and the base thoroughly heated; this was followed by a massive roentgen-ray treatment.

At the June, 1921, meeting of the American Medical Association in Boston, the American Radium Society was the guest

of the Harvard Cancer Research Commission at the Huntington Memorial Hospital. Many interesting things were discussed by members of the commission, but one thing stood out as being more practical than all the others.

Dr. Bovie, a biologist, told of the effects of the roentgen rays, radium and heat upon cancer cells. He said that a certain dose of roentgen ray would only sicken the cancer cell and that heat would do the same thing. He then said that if the cancer cells were first treated with the roentgen ray and sickened, as he called it, that they were then much more susceptible to the heat and easily destroyed.

PLATE 3. Cancer of the lip which had undermined the normal skin and mucous membrane. The undermined portion was exposed by electro-coagulation, as shown in the middle picture. One *x*-ray treatment with the above end result.

PLATE 4. Cancer of the tongue before treatment, after electro-coagulation, and showing radium needles in place. The involved area was about one inch in diameter. This was thoroughly burned away and radium needles imbedded through the base of the ulcer and into the root of the tongue. Deep roentgen-ray therapy was used over the glands of the neck. The end result was good.

Since learning of this fact from Dr. Bovie, I have reversed the process of treating skin cancer. I now give a massive dose of the roentgen ray to the growth and surrounding tissue, and then destroy the superfluous tissue by heat, using the electric coagulation method. As an added measure we frequently apply radium to the open ulcer, using all three agents or methods at one sitting. This may be called a gun-shot method, but I have found it very efficient. The patients are sent home with instructions about keeping the ulcer clean and are asked to return in one month.

The large majority are healed when they return. Patients frequently fail to return, but upon inquiry, I learn that healing has taken place. A few cases will need an occasional roentgen-ray treatment to complete the healing process.

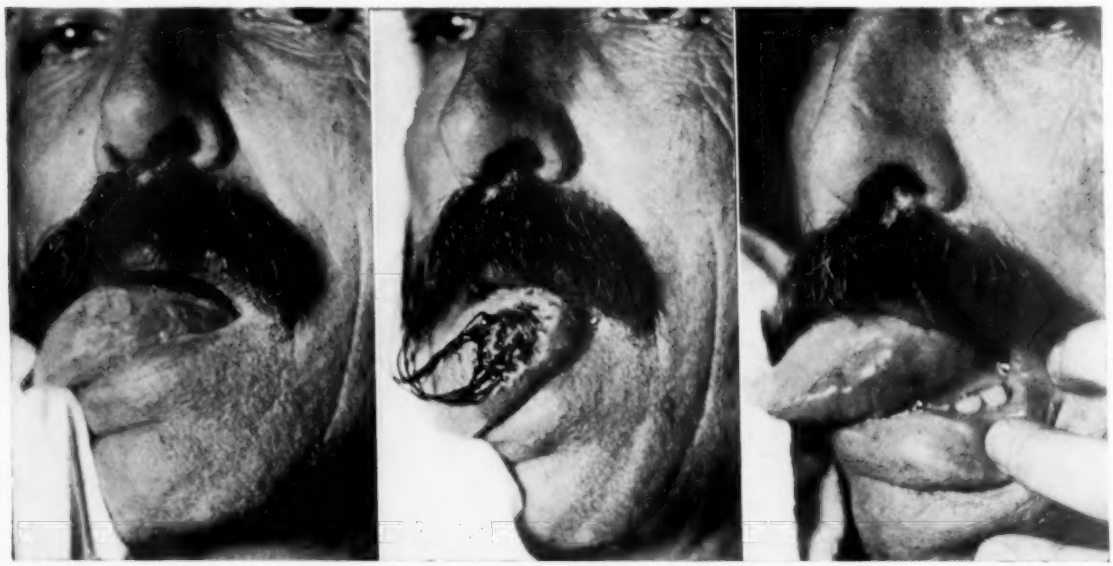

PLATE 5. First, cancer of the tongue; second, after electro-coagulation and radium needles inserted; third, end result. Tongue received only one coagulation and radium treatment. Later roentgen-ray treatments were applied to the cervical glands.

## DISCUSSION OF PAPERS BY DRS. HAZEN AND BOWEN

DR. GEO. E. PFAHLER. I just want to talk on one or two points. First I want to say that my experience conforms exactly with that of Dr. Bowen, and I carry out the same technique. I believe, however, that there is perhaps greater advantage in destruction preceding radiation, as Dr. Bowen has written and said. Heat also partially devitalizes these cells and therefore the *x*-ray will have a correspondingly greater effect because of that preceding heat. Many of the malignant cells may still be remaining in the tissues at the time of radiation.

The patients that electric coagulation will help and that radiation will not help are those having involvement of cartilage or bone. You who have had much experience, know that if you keep on radiating cartilage that has been involved by epithelioma, you do not cure unless you first destroy the disease by coagulation.

Warts: Warts that grow around the fingers and especially those underneath the nails, I have found it difficult to cure by either radium or *x*-ray. They disappear but do not get well. Those which have given me the best results were treated by the combination of coagulation and radium.

DR. A. H. PIRIE. Dr. Hazen mentioned superfluous hairs after treatment of acne. I have never seen that. Dr. Hazen has had an opportunity to follow up his cases. Did he follow up cases of superfluous hairs following acne? I have seen superfluous hairs following treatment of tuberculous glands. When treating such cases I have found hair to grow long where the edge of the protecting lead covered the neck. The

skin is vignetted at the edge of the protecting lead and this vignetted area receives just the right dose to stimulate growth of hair.

These superfluous hairs follow acne as Dr. Hazen said; but are they not temporary and do they not go away afterwards? I have found that hairs following treatment of tuberculous glands do go away.

Dr. Hazen mentioned that the *x*-ray was not good for lupus erythematosus. I have found solid carbon dioxide treatment followed by perfect cure. He also mentions hyperdridosis. I have treated that since 1909 and never had a case that did not respond. The only complaint I have had is that the patient gets too dry and desires to have a little perspiration left.

Dr. C. F. Bowen (closing discussion). In regard to massive dose; I use 7 in. backup, 8 in. distance, 5 ma., for ten minutes;—no filter. If there is any likelihood of the glands being involved, I give the heaviest dose and heaviest backup I can use on all glands of the neck and lymphatic glands involved. In that case I use 10 mm. al. and sole leather, about 9¼ in. backup,for twenty minutes, at an 8 in. distance. I use a single dose in those cases where I think there is no malignancy and no glandular involvement. When finishing, I tell the patient that if he gets a swelling around the neck he must come back. I then treat it as an internal case and not as superficial malignancy.

Dr. H. H. Hazen (closing discussion). Dr. Pfahler said that warts underneath the nails do not respond to *x*-ray. I must have been remarkably lucky because I have had a series of eight cases and all of them are well,—permanently well. I attribute this entirely to luck.

With regard to the treatment of keloids: I think a great deal of the technique depends upon the keloid. If it is one that is very much infiltrated, I use filter of 2 mm. al. The technique for a small keloid, about the size of a quarter and not over 1/16 to ⅛ of an inch thick, is as follows: 1½ skin unit, measured by Mac Kee's formula, 9 in. distance, 1 min. and thirty-five to forty seconds, 7½ in. backup, 4½ ma. three weeks' interval, 4 to 6 treatments. With deeper keloids, of course, we use a certain amount of filtration.

Acute eczema: There are two types of eczema. One is clearly due to external irritants and it is not necessary to use the *x*-ray on these cases. In the vast majority of cases of so-called acute eczema we use *x*-ray right away, and we do not believe that the *x*-ray is contraindicated in the vast majority of acute eczema cases. We use it daily and with good results. We use the same dose as for acne, ½ skin unit, thirty-five seconds, 9 in. distance, 7½ in. backup, 4 ma. over about ten days to two weeks.

Superfluous hairs: We have seen a number of cases of superfluous hair following acne, which have been permanent over four or five years; and I am inclined to think they are going to continue. In addition, the vast majority of superfluous hair are those who have had acne when hair developed. They come in for needling work.

With reference to the use of carbon dioxide snow in treatment of lupus erythematosus. There are two types of this disease—acute and chronic. Carbon dioxide snow in the acute cases does not work well. I am partial to carbon dioxide snow in chronic cases. I have found it better than the ultra violet light. I have had better success with its use.

Acne and tonsils: We have had a theory for awhile that acne might be made worse because of bad tonsils. We have had 3 cases in one week where acne developed after bad tonsils were taken out. We have had six or eight acne patients whose tonsils have been removed without influencing the acne at all.

# PERISTALSIS OF THE COLON

BY PRESTON M. HICKEY, M.D.

DETROIT, MICHIGAN

WHEN a patient is given an opaque meal, the peristalsis of the stomach and small intestine can be easily studied from the fact that the peristaltic waves affecting the stomach move along with a rapidity which is favorable usually for their observation, but the rate of travel may be either so rapid that the movements are difficult to follow, or so slow that the observer's patience becomes exhausted. The peristalsis in the small intestine is usually easy to be studied. The rate of travel, while often very rapid, easily permits of accurate observation.

When the patient is given a barium meal by mouth, the peristalsis in the colon is so slow and so infrequent that opportunities are rarely found when the movements may be observed. In consequence of this infrequency of colonic peristalsis, comparatively little is known about its method of appearance, and the observer has no chance of witnessing the rate of travel of the colonic peristaltic waves, the frequency of their occurrence and the vigor of their action. In the great majority of observations upon the colon, whether it is filled by a barium meal or filled from a barium enema, the examiner can report only the size, shape and relation of the component parts of the large gut.

If one is desirous of observing colonic peristalsis, the following procedure is recommended: After a cleansing of the large gut, either by enemata or by laxatives, the colon is filled by injecting through a soft rectal tube the usual barium enema. After the colon is completely filled, preferably slightly distended, the examiner disconnects the rubber tube from the enema reservoir and lowers it into a covered pail for the reception of the return flow. The colon, being stimulated to activity by the presence of this large amount of fluid which naturally is mildly irritating, becomes the seat of peristaltic contractions which may then be conveniently studied. If the ampulla of the rectum has been over-distended, there is a rapid emptying of it which is later succeeded by emptying of the sigmoid. After the emptying of the sigmoid which does not usually reveal active peristalsis but rather the exit of the fluid by a process of tightening, we find that peristalsis begins to be observed in the transverse colon. The point of the starting of the peristaltic wave being usually found to occur about the junction of the middle and right third of the transverse colon. The peristaltic waves having their origin at this point pass along the transverse colon, partly emptying the same, and force the content of the gut along through the splenic flexure, distending the upper portion of the descending colon. Here usually the peristaltic waves become interrupted for a time and then pass on emptying the lower portion of the descending and starting up two peristaltic waves in the sigmoid. After the transverse and descending colons are partly emptied, the peristalsis, in a normal gut, is seen to start in the lower portion of the cecum and empty the same very rapidly. Such is the usual phenomena observed when the colon filled by a barium enema is watched during the process of evacuation.

One of the advantages of this procedure is the ability to differentiate between the spastic constrictions of the transverse colon, for example, and organic strictures. One of the first cases examined by this method gave very instructive results. The clinical history was that a woman of sixty years of age who had been examined and a tentative diagnosis of annular carcinoma of the first portion of the transverse colon had been made. A narrowing of the gut at this point was observed, both by observation of the colon after the barium meal, and also after the barium enema. Manipulation of the transverse colon failed to satisfactorily fill this apparent defect. The patient's general appearance seemed to substantiate the tentative diagnosis of carcinoma at this point. However, there seemed to be a very reasonable doubt as to the correctness of a diagnosis

of malignancy. However, the patient after being given a barium enema on a subsequent examination, the process of the emptying of the colon was watched and it was noted that the peristaltic waves as they passed along the transverse colon produced a relaxation of the spasm and the spastic constriction disappeared with a full relaxation of the muscular fibers as the waves passed along. In this case, the possible diagnosis of malignancy which was under debate for some time was disproved in a very graphic fashion and in a way which admitted of no further argument.

When one recalls the number of cases which have been operated upon for supposed malignancy in the transverse colon and where the findings at operation were those of an apparently normal colon, it is realized that this procedure of watching the colonic peristalsis is a valuable aid in diagnosis.

In watching the behavior of the peristaltic waves about the cecum in cases of right lower quadrant symptoms persisting after the patient has had the appendix removed, it was found that the peristaltic waves in the region of the cecum do not start at the tip as in an apparently normal cecum but start at the junction of the middle and upper third of the cecum. In some of these cases, the point of beginning of the peristaltic wave was very marked, giving the observer the impression of a band tied around the upper portion of the cecum. This appearance was found in few cases where the examination was made for the purpose of determining whether the patient presented the roentgen-ray findings of a so-called chronic appendix before the appendix was removed. In those cases where it was found by the barium meal that there was cecal retention, as well as retention in the appendix, the barium enema when observed with a returned flow catheter showed the sharp constriction at the junction of the middle and upper thirds. These findings substantiate the observation that in the upper portion of the cecum is often found a valve-like action of the constrictor muscular fibers.

In cases of constipation due to atony of the colon, we find the peristalsis very slow in starting, often requiring mechanical massage of the abdomen over varying areas of the colon to start the peristaltic waves. It is possible also by this method to study the comparative response of different sections of the colon to abdominal massage. Observations are being made at present to determine the value of this method in the investigation of tuberculosis of the cecum.

In conclusion, we believe that the use of the return flow rectal catheter after the introduction of a barium enema affords an easy method of studying normal colonic peristalsis, and also the variations produced by intracolonic pathology.

# THE AMERICAN JOURNAL OF ROENTGENOLOGY

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TWENTY-THIRD ANNUAL MEETING THE AMERICAN ROENTGEN RAY SOCIETY

LOS ANGELES, CAL., SEPTEMBER 12, 13, 14, 15, 16, 1922

*Headquarters, Meetings and Exhibits: Hotel Ambassador, Los Angeles, Cal.*

## THE LEONARD PRIZE

The American Roentgen Ray Society is again offering the Leonard Prize in 1923, details for which appear on advertising page vii of this number of the Journal. The manuscripts submitted for the 1921 prize were of a high order of merit and covered a variety of subjects pertinent to Roentgenology. It is to be hoped that the contestants for the next prize will be equally zealous in their efforts.

## LOS ANGELES MEETING

One afternoon of the Los Angeles session will be devoted to "sealed verdict" cases.

Any member having an interesting or unusual case, the roentgen diagnosis of which has been verified by surgery, pathological section or post-mortem examinations, is requested to send in lantern slides of the roentgenograms and a full clinical history. The verified diagnosis should also be forwarded in a sealed envelope. After the clinical history has been read and the lantern slides shown, an opportunity for all to express an opinion will be given. When everyone has made a "snap diagnosis" the seal will be broken and the verdict read.

All members of the Society, especially those not presenting communications at the annual meeting, are requested to take part in this portion of the program.

Send all communications regarding the above to:

Dr. W. H. Stewart,
222 West 79th Street,
New York City.

## ANNOUNCEMENT

The Fourth Italian Congress of Radiology will take place at Bologna on May 9th, 10th and 11th at the Rizzoli Orthopedic Institute, under the presidency of Prof. Aristide Busi.

Annexed to the Congress an Exhibition of radiological apparatus will be held in which Italian, as well as foreign firms, may participate.

For further information apply to Dr. ALBERTO POSSATI, Secretary of the Congress, Villa Verde, Bologna.

## CORRESPONDENCE

To the Editor:

There seems to be a considerable misunderstanding regarding the use of certain terms relating to the measurement of kilo-voltage of an *x*-ray tube. It occurred to me that it might be advisable to have this explained in the columns of the AMERICAN JOURNAL OF ROENTGENOLOGY, so that roentgenologists would have, at close hand, a place of reference in the future.

The misunderstanding seems to have arisen after a paper that I read in Chicago, in which I used the term "crest value."

We sometimes hear the term "peak value." After I had read this paper, using the term "crest value," there seemed to arise an opinion that I was introducing a new term. This is not the case, however. The terms "crest value" and "peak value" are used to mean the same thing, the difference being that the term "crest

value" is standardized as the proper term by the American Institute of Electrical Engineers. This body of professional men publish a book called "Standards of the A. I. E. E.," and if one refers to the index of this book (1921), one will find that the term "peak value" does not appear. But, if the definition for crest factor or peak factor be consulted, the term "crest value" will be found defined. Section 3266 reads as follows: "*Crest factor* or *peak factor* of a wave is the ratio of the crest, or maximum, value to the r.m.s. value." Therefore, the term "crest value" is the proper term and "peak value" is not.

Section 8004 defines *Crest Voltmeter:* "A crest voltmeter is a voltmeter depending for its indications upon the crest, of maximum value of the voltage of the system to which it is connected. Crest voltmeters shall be marked in true crest volts and also in the r.m.s. value of the sinusoidal wave having the same crest value."

Section 2362 relating to *Measurements with Voltmeters*, states, relating to testing kilo-voltage: " . . . testing voltage must be checked by a spark gap as set forth in 2364 and 2366 or by a crest-voltage meter."

Dr. H. M. Imboden:

Thus we have as crest voltmeters any kind of a device which depends upon the crest or maximum value of the wave for its reading.

Needle point gaps are acceptable within their ranges of voltages and certain size sphere gaps are usable within their ranges of voltages. There are also other devices which give continuous crest value reading which come within the specifications of the A. I. M. E., among which might be mentioned those of Farnsworth & Fortescue, Sharp & Doyle, Simplex Instrument, that of Ryan, and others.

Particular attention is directed to the fact that the A. I. E. E. *Standardization Rules* does not say that the crest value must be measured with a sphere gap nor does it say that only sphere gap measurements will be considered as standard, but only that the readings of the metering device must depend upon the *crest* or maximum value, only.

MONTFORD MORRISON

Consulting Engineer Research Laboratory
International *X*-Ray Corporation
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# TRANSLATIONS & ABSTRACTS

STONE. WILLIAM S, The Present Position of Radium in the Study and Treatment of Uterine Cancer. (*Surg., Gynec. and Obst.*, June 1921.)

This entire article deserves careful reading by both the surgeon and the radiologist. It is possible here to give only the author's conclusions.

The histological changes produced in malignant tumors by the action of radium are described and the author states that clinical reparation follows such histological changes in tumors of the uterine cervix with such regularity that radium seems to have an almost specific effect.

From the study of 400 cases of uterine cancer the writer offers the following as the present therapeutic position of radium. In all recurrences it produces immeasurably better results than operation, provided they are not too far advanced and are not so closely associated with bladder or rectum that fistulae or severe functional disorders will result. Treatment of recurrences must be within narrower limits than in primary cases but in numerous instances it is possible to relieve pain, stop hemorrhage, and hinder the progress of the growth by one carefully adjusted dose, even when the advanced stage of the disease precludes the idea of any considerable regression.

Radium should be considered the method of choice for treatment of all cases of primary uterine cancer, with very few exceptions. Statistics of cases treated at the Memorial Hospital are given in support of this view.

Radium has particularly demonstrated its value in the so-called borderland cases. "With a properly adjusted dose and form of application, radium may be expected regularly to destroy all intra-uterine tumor tissue, and it is capable of destroying extra-uterine tumor tissue to a depth fully within the limits of what is generally regarded as operable with more certainty than operation." Operation after radium has produced an apparent regression of the tumor is probably a mistake. If radium treatment has produced an entire cure, operation is unnecessary, and if it has simply caused degeneration of the tumor cells and their encasement in fibrous tissue, operation can only serve to destroy the framework of fibrous tissue and free the cells for further activity.

When radium is used in conjunction with operation it is best used prior to it, but is also valuable as a prophylactic measure following operation.

Numerous cases of cauliflower growth are best treated by removal of the mass by the actual cautery and application of radium to the base, but care must be taken in these cases not to produce too far-reaching an effect.

In cancer limited to the body of the uterus the writer believes that operation is the only safe method of treatment. Radium, however, does not stimulate nor unfavorably influence such lesions and should be used one or two weeks prior to operation. He believes that such use will materially improve the results that have hitherto been obtained by operation alone.

Cancer limited to the cervix, especially if lymph nodes are involved should be operated upon but there should also be a previous application of radium.

The writer discusses the relative value of large amounts of radium used for a short time and small amounts used for a long time. Attention of those using a small amount of radium is directed to the necessity of adequate filtration and avoidance of the use of the soft beta radiation either by filtration or by obtaining distance by means of vaginal gauze packing. There should be a better appreciation of the undesirable effects of radium upon necrotic and infected tumor tissue. "In general, the chief error in the use of radium is overdosage."

A final plea is made to avoid treatment of primary cases that are too far advanced. Such treatment serves only to produce unnecessary suffering and will soon discredit the use of radium.

A. C. CHRISTIE.

WILLIAM P. GRAVES, Present Status of the Treatment of Operable Cancer of the Cervix. (*Surg., Gynec. and Obst.*, June, 1921).

"The immense value of radium as a palliative agent in relief of inoperable cancer of the cervix was immediately established when it was first employed. The problem that confronts us at the present moment is not with regard to general value of radium in relieving symptoms and prolonging life; the specific question is whether we are justified in resorting to the simple application of radium in cases that are frankly operable, and in which an ultimate cure by surgical means is reasonably possible." The writer's personal experience answers this question somewhat as follows. There have been numerous surprising temporary cures from the use of radium which always eventuate in recurrence. The preoperative treatment of

border-line cases has been disappointing. Postoperative use of radium has resulted in prolonging life in comparative comfort, but without cure. So far as known he has not cured any case of inoperable cervical cancer. The logical outcome of his own experience in the use of radium in inoperable cancer is the conclusion that he is not justified in substituting it for radical surgery in cases favorable for operation.

The writer discusses his results in 119 cases of radical operation for cervical cancer, with 6 deaths due to the operation and a five year curability percentage of 27.6 to 34.2, according to the method of computation.

Conservatism in the surgical treatment of cervical cancer has been made more rational by the advent of radium, for there is no longer the necessity for attacking the far advanced cases.

"Whether the ultimate treatment of curable cases shall continue to be surgical or whether surgery shall yield to radiation, the general outlook is encouraging. It depends in great measure upon the success that attends our efforts to educate the laity and profession to an earlier detection of the disease."

A. C. C.

FOWLER, W. FRANK. Benign Gastric Ulcer in a Known Syphilitic: A Résumé of the Literature Concerning the Diagnosis of Organic Gastric Syphilis. (*Surg., Gynec. and Obst.*, May, 1921.)

The writer summarizes his communication as follows:

Organic gastric syphilis is more frequent than formerly supposed. The gross lesions of gastric syphilis are (1) gummata in various forms, and (2) diffuse infiltration. Specific ulcers result from the degeneration of gummata. Symptomatically such lesions differ from benign ulcers chiefly in the absence of pain, ease from food and alkalies, less periodicity, anacidity, vomiting with good appetite, excessive weight loss and improvement in gastric function with specific treatment. Without operation the diagnosis usually rests upon a past history of early syphilis, present late syphilitic signs, Wassermann reactions and the therapeutic test. However, a negative Wassermann reaction does not exclude the possibility of gastric syphilis, and benign lesions of the stomach may occur in a known syphilitic. At operation specific ulcers are always multiple, ragged lesions occurring usually at the cardia, the lesser curvature, or the pyloric region accompanied often by perigastric adhesions, thickened gastric walls, and gastric deformity. Large gummatous tumor masses or cicatricial contractions subsequent to extensive ulceration simulate carcinoma, particularly as regards the type of dyspepsia, the vomiting, the rapid weight loss, and the anacidity, although the cachexia and loss of strength are less than that encountered in malignancy, and the course may have been longer. The operative findings consist, usually, of an irremovable gastric tumor mass indistinguishable from carcinoma. The *x*-ray evidence also simulates carcinoma. The roentgenographic signs of organic gastric syphilis in general consist of encroachments upon the lumen, distortions, and deformities. The microscopical evidence consists of the characteristic syphilitic obliterative endarteritis and perithelial lymphocytic infiltration with atrophy of the mucous membrane and hypertrophy of the submucosa and the muscularis. Post-mortem confirmation of the diagnosis is infrequent.

Conclusions:

1. Organic gastric syphilis may simulate (a) benign gastric ulcer, (b) gastric carcinoma, or (c) present an atypical gastric picture.

2. The diagnosis of organic gastric syphilis is often difficult and sometimes impossible.

3. A negative Wassermann reaction does not disprove the existence of syphilis and a positive reaction does not prove that a gastric lesion is specific.

4. The "therapeutic test" is usually reliable but not infallible.

5. The roentgenographic evidence is not conclusive.

6. Exploration may not be determinative, particularly as regards differentiation from carcinoma.

7. Atypical, chronic gastric disorders which are unresponsive to the usual treatment should arouse suspicions of syphilis.

A. C. C.

PIRAZZOLI. The Oculo-Esophageal Reflex as Seen on the Screen. (*Radiol. med.*, September 10, 1921.)

In the course of his routine work in the radioscopy of gastrointestinal diseases the author has been able to study an oculo-esophageal reflex, a phenomenon which does not seem to have received attention before. It seems to be accompanied by the oculocardiac reflex almost constantly, being elicited by the same pressure on the globe of the eye. At the instant of compression the subject is asked to swallow a large gulp of fluid. The pulse is tested at the same time in order to note the presence or absence of the oculocardiac reflex. The examination of the screen in the right anterior oblique position shows that at the moment of compres-

sion of the eyes the esophagus dilates and then rapidly evacuates itself. The pneumogastric nerve distribution makes possible this reflex. Water is held in the mouth at the time of the test.

The other or sensory portion of the reflex arc is the trigeminus nerve. The reflex proper is the sudden dilatation of the esophagus, the subsequent contraction being the sequel.

This phenomenon may have some diagnostic value in doubtful cases of stenosis, in spastic conditions, etc., by showing that the esophagus is intact.

HOFFMANN. Radiotherapy of Mammary Carcinoma. (*Beitr. z. klin. Chir.*, 1921, cxxi, Heft 2.)

This author has collected material from the surgical clinics of Tübingen, Marburg, Rostock, Heidelberg, etc. and finds that radiotherapy for breast cancer is in the tentative stage. The absorption of the rays may be reckoned as 100–110 per cent of the erythema dose of the skin. But the intensity diminishes rapidly as the rays penetrate and at a depth of 2 cm. possesses only 70 per cent of that of the surface. This necessitates compensatory raying. The postoperative effect is the more commendable as the indications to prevent the recurrence are coherent. If the nodules of recurrence can be reached, they will disappear. Attempts should be made to reach cancer cells which the operation may have left behind, and which will provide the nodules of recurrence. The author does not favor the promiscuous and excessive radiation of the thorax.

In the present state of our knowledge we are not justified in radiation before operation. The ratio of success for scirrhus is one benefited or cured for the time out of 2 treated: while in the case of medullary cancer this ratio is one to 3.6. These ratios seem to refer to surgical results and show what radiation must accomplish to equal surgery.

BANCROFT, FREDERICK W. Acute Haematogenous Osteomyelitis. (*Ann. Surg.*, June, 1921, lxxii, 6.)

A study of acute haematogenous osteomyelitis in children with drainage and postoperative Dakinization leads to the assumption that it might be possible to sterilize dead particles of bone, obviously sequestra from the roentgenogram, and permit them to be assimilated into the reparative process in the same manner as sterile bone grafts.

In an effort to determine the practical possibilities of such a method, a sterile osteomyelitis was produced in animals by inserting through a small opening in the bone, a capsule containing croton oil and plugged with agar-agar. The croton oil was confined in its container for a sufficient length of time to permit primary healing of the cortex before any evidence of the destruction caused by the liberated croton oil could be seen.

The sterile osteomyelitis which resulted caused extensive bone destruction and in several cases pronounced sequestration. This sequestration process was examined, not only from a roentgenographic standpoint, but also in gross and microscopic sections. True sequestration had occurred which in time was incorporated in the new bone formation. This would tend to show that sterile sequestra might be expected to act as bone grafts when present in the path of new forming bone.

Two cases in human beings were sighted and well illustrated, which suggest that a definite sequestrum, even in pyogenic osteomyelitis, may by Dakinization be rendered sterile, so that it may be incorporated in the new bone.

L. R. SANTE.

GÄHWYLER, M. Nontuberculous Adenopathy of the Bronchial Glands and Calcification of the Same. (*Schweiz. med. Wchnschr.*, April 7, 1921, li, 14.)

According to the author, the presence of a deepened hilus shadow and the appearance of calcification must not be assumed as tuberculous. The profession have gone too far in this interpretation of *x*-ray plates. In some cases an ordinary hilus shadow has been so interpreted. The *x*-rays register these appearances, but the diagnostician must use other methods to make the differential diagnosis. The author now gives in detail case histories, of which we may repeat one. The patient was a boy, fifteen years of age who gave a history of much throat trouble from the age of six. After extirpation of the tonsils he had had numerous attacks of angina with fever. He kept well for a year, but had a return of the anginal attacks with dyspepsia and palpitation. He was a rugged boy, weighing 121 pounds, with enlarged, hard cervical lymph-nodes, sensitive to pressure, isolated. The physical signs suggested tuberculosis, but numerous repeated von Pirquet's and general tuberculin tests were negative. In the author's sanitarium at Arosa he soon lost his fever, but went through an attack of influenza which left him with a spasmodic tracheal cough difficult to control until a false membrane detached itself. At the same time a temperature of 104° subsided to normal. The *x*-ray findings at this juncture were cloudiness in the right

apex; enlarged hilus shadow, diffuse with dim contours; while beneath the middle of the clavicle were two pea-sized bodies. The appearances in the left hilus were somewhat similar. The right lung was dull on percussion to the midscapular region; there were roughened breathing and reinforced whispering voice. Despite the suspicious evidences, the diagnosis was nontuberculous infection of the cervicobronchial lymph-nodes.

The *x*-ray signs of bronchial tuberculosis, as described by at least four authoritative works on the subject, were found in 5 of these 7 cases, while two other writers demand something more than a mere increase of the normal hilus shadows. Conversely we know that rarely in bronchial tuberculosis are the usual *x*-ray appearances in evidence. Some of the most recent contributions to the subject contain opinions much less confident than those expressed by earlier workers. Thus Bandelier and Röpke state that the difficulties of recognition are underestimated. Much states that differentiation between tuberculous and other conditions may be almost impossible. Gottschalk has seen presumptive tuberculous shadows in asthma, and Güterbock mentions non-tuberculous bronchites with adenopathy of the hilus glands. After quoting other dissenting opinions the author sums up by stating that non-tuberculous affections of the bronchial glands may give all the evidence of tuberculosis, including the roentgen-ray plate and d'Espine's sign; that there is no typical *x*-ray plate of bronchial gland tuberculosis; that in the most varied conditions there may be enlarged and even calcified bronchial glands; that Nägeli's old autopsy findings should be revised up to date, as indicative of latent tuberculosis, and that no diagnosis of bronchial gland tuberculosis should be made without a tuberculin subcutaneous reaction test.

Pochon, G. (Paris). Tuberculosis and Decalcification. (*J. de méd. de Par.*, 1921, March 10, xi, 7.)

This subject is of great importance, but seems to have attracted but little attention from roentgenologists. If, as is claimed, the tuberculous subject has lost lime, either as a result of or contributory factor to his disease, and if, as is alleged, this decalcification should be sufficient to show at times in the shadow of the skeleton, the numerous plates of consumptive thoraces and long bones—in the case of surgical tuberculosis—do not seem to show any such state of affairs, nor is there any comment of any sort in the average *x*-ray report on the state of the skeleton. About 1900 Paul Ferrier wrote a classical paper on the relation between caries and tuberculosis. This and subsequent reports appear to show that the consumptive has somewhat more caries than the average dispensary patient and perhaps twice as much as the sound subject. In the absence of the literature we are ignorant as to the period at which decalcification appears, but find the statement that caries is seen in the pretuberculous period, and hence is rather a cause than an effect. A similar theory, not mentioned by Pochon, was set up years ago as the basis of the treatment of tuberculosis by hypophosphite of lime. Pochon relates the case of a highly tuberculous family in which the contagion must have been propagated from person to person. One of the children, tuberculous at the age of eleven (tracheobronchial glands), subsequently outgrew his condition and at nineteen was playing football. In this game he sustained a fracture of the leg in which the roentgen-ray examination showed total failure of callus formation and general decalcification of the skeleton. The patient had to wear a brace by reason of the incomplete union, although there was no pseudarthrosis. After the accident there was a sudden development of pulmonary tuberculosis. Both happenings are attributed to decalcification.

Palugyay, J. (Vienna). Traction-Diverticulum of the Esophagus Shown by Radioscopy. (*Wien. klin. Wchnschr.*, April 7, 1921, xxxiv, 14.)

As a rule this affection is silent during life and is discovered by chance at autopsy. In contradistinction from pulsating diverticula there is no interference with swallowing, nor does the cavity become stuffed with food, because its opening is wide and the volume small. Symptoms tend to appear only in infection, with ulceration or necrosis at the apex. But one case is on record of satisfactory demonstration by *x*-rays of a traction diverticulum reported by Helm in 1918, and the author is able to add another. Patient was a man of fifty-nine years with cancer of the fundus of the stomach extending to the cardia. Repeated roentgen-ray plates and ordinary inspection of the esophagus failed to bring this malformation to light. In one plate a concentration appeared in the mediastinal area which suggested a possible induration. Finally, however, the screen was used in the Trendelenburg position to bring out the function of the cardia. When contrast-pulp was introduced into the esophagus, peristalsis was seen to extend to the cardia, the contrast-mass being carried to this point, and as it passed the level

of the tracheal bifurcation the shadow of the diverticulum appeared—of funnel shape with rounded apex, directed obliquely cranialwards. This was about the size of a small plum, the opening being about 1.5 cm. broad. After the contrast-mass had been carried along, some of it still remained in the diverticulum, which was on the right side of the esophagus at the level of the bifurcation.

Upon the death of the subject from cancer, autopsy confirmed the diagnosis. On the screen it would hardly have been possible to exclude pulsating diverticulum. Perforating cancer of the esophagus would not have been compatible with the smooth walls of the diverticulum and of the near-by esophagus. The character of the peristalsis should have excluded the likelihood of spasm of the esophagus.

EDLING, LARS (Lund). On Plastic and Elastic Means of Application in Radium Therapy. (*Acta Radiologica*, Sept. 20, 1921, Vol. 1 No. 2.)

This work gives a report on a method of application in radium therapy originally discovered by the author in 1915 and developed by him in the following years by the use of plastic dental compounds.

The first part of the work describes the origin and development of the author's method. His technique may be thus summed up:

*An impression of the tumor and its immediate neighborhood is prepared out of the plastic compound. On the outside of this cast the radium tubes and filters are attached according to the indications furnished by the impression, the plastic compound itself serving partly as a secondary filter and partly as a means of regulating the distance of irradiation. Finally, both the protective arrangements for the healthy tissues and the actual fixing of the apparatus are secured by the aid of the plastic compound.*

This method may be used not only in skin diseases, but also on the tumors of a great many mucous membranes.

Further on, the author dwells in considerable detail on the results of the chemical and physical researches brought about by him in order to investigate the filtering properties of the dental compounds. Among the compositions thus analyzed the "Kerr Perfection Impression Compound" proved by far the most suitable. All the compounds seem to have a percentage of inorganic substance, varying between 50 and 57 per cent and virtually consisting of aluminum-magnesium oxide, probably a modification of the mineral *Spinel* ($Mg_0$, $Al_2$ $O_3$). This is to be regarded as an advantage, since aluminum and probably also magnesium are distinguished by giving a relatively inconsiderable secondary radiation.

The filtering measurements of the plastic mass have been carried out by comparison with the secondary filter mediums heretofore generally used, viz: india rubber, paper and surgical gauze, and have given the following results, illustrated by curves:

(*a*) The impression compounds as well as the secondary filters just named absorb the primary radiation of radium in a very slight degree (12–20 per cent of the total radiation).

(*b*) As to the emergence radiation of the secondary filtering mediums as such, it will rapidly increase with a very thin layer of material (about 1 mm.) but then again rapidly diminish; with "Kerr," it is considerably less than with the other secondary filters (at least in thicknesses of 2–10 mm).

(*c*) The measurements of combinations of lead filters with various secondary filter mediums have shown that these will cause a considerable decrease of the emergence radiation with thin layers of the material (as to "Kerr" by a percentage of about 80 per cent with a layer 1 mm. thick, an absorption that will remain nearly constant with an increase of thickness up to 10–11 mm., which proves the advantage of that substance in radium therapy).

In the following parts of the work the author gives an account of the general principles of the use of the plastic substance in therapeutics, and further, in special chapters, detailed descriptions of the different appliances and modifications afforded by the plastic method in the treatment of tumors of various skin regions, of the lips, of the mucous membranes of the mouth, jaws, palate and tongue. Next he discusses the application of radium in the upper air-passages, including the palatine arches, and finally in the female genital organs. As to these different details, however, we must refer to the work itself.